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ANGIOCARDIOGRAPHY IN CONGENITAL HEART DISEASE

I. DEXTROCARDIA

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THE term "dextrocardia" has had varied usage. The definition given by Dorland's Dictionary (1941) is "transposition of the heart to the right side of the thorax." This is inclusive of instances where the position of the heart is the result of congenital malformations as well as those due to acquired diseases. Brown[1], however, feels that the term should be limited to the congenital group. By some the term has been reserved for the "mirror-image" type with complete or partial transposition of the viscera, "isolated dextrocardia" being applied when visceral transposition is absent. Vaquez and Bordet[11] describe all cases with a right-sided heart as dextrocardia, regardless of the position of other organs, differentiating only between congenital and acquired displacement.

For purposes of discussion, the following classification for dextrocardia is proposed:

Type I. Dextrocardia with complete or partial transposition of viscera (situs inversus).

The relationship of the heart to the viscera is unaltered resulting in a "mirror-image" of the normal. The electrocardiographic pattern shows complete inversion. The electrical axis runs from left to right being rotated 180° from the normal.

Type II. Dextrocardia without transposition of viscera, with inversion of the cardiac chambers.

The heart is transposed as in complete transposition, the left ventricle lying in front and the right behind. The electrocardiogram is of the "mirror-image" variety.

Type III. Dextrocardia without transposition of the viscera with normal arrangement of the cardiac chambers.

The left ventricle lies anteriorly, the right posteriorly. The aortic arch presents on the left border and the aorta descends to the left of the spine. The electrocardiographic pattern shows a normal electrical axis.

Type IV. Dextrocardia associated with congenital abnormalities of the thoracic cage, diaphragm or lungs.

The arrangement of the chambers is normal and the electrocardiographic pattern shows a normal electrical axis.

Type V. Acquired dextrocardia.

The displacement of the heart occurs post-natally as a result of diseases of either the thoracic cage, lungs, pleurae or diaphragm.

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Fig. 1. Case 1. Conventional roentgenogram showing dextrocardia. The heart is enlarged in its transverse diameter. The upper electrocardiograms are taken with conventional leads, the lower electrocardiograms with leads I and II reversed.

The above classification is somewhat modified from the one adopted by Mandelstam and Reinberg.[3] It is recommended because it accepts the general definition of dextrocardia but clearly subdivides each variety on the basis of its genesis.

EMBRYOLOGY

The origin of the various types of dextrocardia is in different teratogenetic determination periods. Between twelve to fifteen days after impregnation, the fetal heart assumes the appearance of an S-shaped tube. A kinking of this primitive tube in a direction opposite to normal has been thought to be the cause of dextrocardia of the "mirror-image" type with either partial or complete situs inversus (Type I). This stage of development of the human fetus corresponds to that in which Pressler and Spemann succeeded in producing inversion and transposition of organs experimentally by mechanical means.[7]

The time of origin of Type II is probably in this same period but is limited to the heart. In some of the few recorded cases there is a partial transposition limited to auricles or auriculoventricular valves. In others there are additional variations in the origin of the great vessels. For example, the pulmonary artery may arise posteriorly and to the right of the aorta (corrected transposition of Rokitansky).[4,8]

In Type III the anlage is completely normal, displacement to the right occurring at a later period, probably the sixth week of fetal life. At this time the heart normally is situated nearly perpendicularly and symmetrically, protruding slightly more into the right hemithorax. For some unknown reason, it does not rotate towards the left side as usual. Type III should therefore be considered a persistence of the fetal position of the heart.

Type IV displacements occur in the fourth to the sixth week—the exact time varying according to which organ is involved in the developmental arrest.

DIAGNOSIS

The correct diagnosis of dextrocardia as part of a complete or partial situs inversus (Type I) offers no difficulties. Similarly, the diagnosis of instances of dextrocardia Types IV and V is relatively easy and may be based on the conventional roentgen findings. On the other hand, the precise differentiation during life between dextrocardia Type II and III may be very difficult, if not impossible. Although theoretically the electrocardiogram should be of absolute diagnostic value, in practice it is a useful criterion only in the absence of other congenital anomalies.[2,6] Zdansky[12] has pointed out that the interpretation of the electrocardiogram in cases of Type II is confused because, with the exception of a few instances, studies have been made without anatomical proof of the presence or absence of inversion of the chambers.

Conventional roentgenography is not of

definitive value in the differential diagnosis of the "isolated dextrocardias," i.e., Types II and III, since the cardiac chambers cannot be distinguished with sufficient certainty.

Angiocardiography affords a means of identification of the individual cardiac chambers, thereby permitting an accurate classification of dextrocardia during life. Using the technique of Robb and Steinberg[5] as modified by us[9,10] 3 cases of dextrocardia have been studied and form the basis of this report.

REPORT OF CASES

Case I. Dextrocardia—Type I.

S.A. (No. 468141), white female, aged twenty-five. At the age of six months a cardiac murmur was discovered and the heart was found to be in the right chest. Until the present illness the patient was perfectly well except for occasional dyspnea on exertion and non-productive cough.

Present Illness. Five weeks before admission the patient experienced a sudden shaking chill. Her temperature rose to 104° F., and remained elevated.

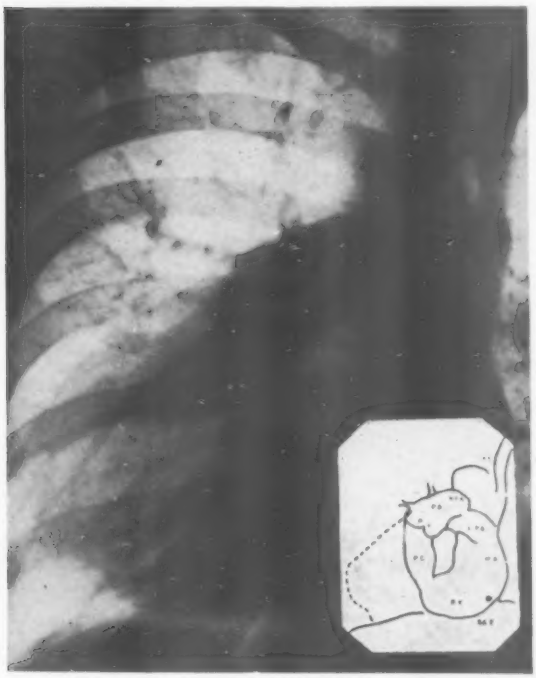

Fig. 2. Opacification of the right auricle and ventricle and of the pulmonary artery on the left side.

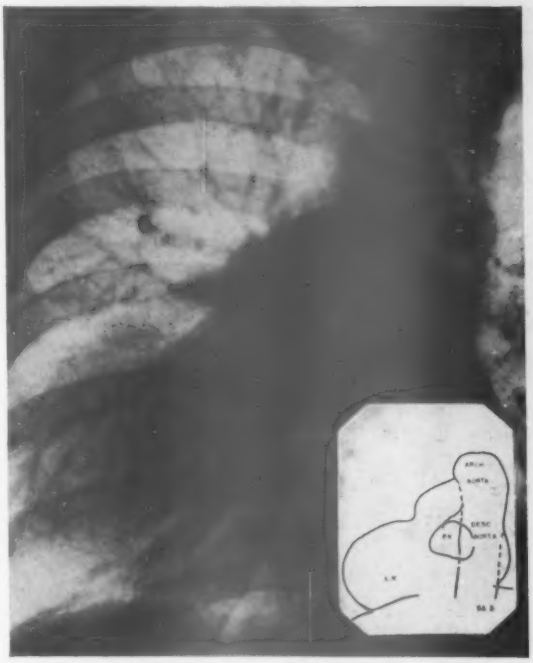

Fig. 3. Opacification of the left ventricle and of the aorta. The findings confirm the electrocardiographic impression of dextrocardia Type I.

Physical Examination. The patient was an obese girl without cyanosis, dyspnea, petechiae. The eyeballs were moderately prominent. There were no abnormal pulmonary findings. On percussion the heart appeared to be in the right chest. The apical impulse was not felt. There was a coarse systolic thrill to the right of the sternum, most prominent in the second intercostal space at the midclavicular line. There was tenderness over the lower sternum and ribs. Blood pressure, 110/60.

Laboratory Data. Hemoglobin 76 per cent; leukocytes 12,000, 88 per cent segmented polymorphonuclears, 21 per cent non-segmented. Urine showed a faint trace of albumin and a few leukocytes. Circulation studies—saccharine time seventeen seconds, ether time seven seconds, venous pressure 13.5 cm. of water. Blood culture revealed *Staphylococcus aureus* in all plates and flasks. *Electrocardiogram*—P1 and T1 inverted, QRS 1 deflected downwards, Leads II and III appeared reversed. Electrocardiograms taken with the arm leads interchanged so that lead 1 was placed on the left arm and lead II on the right arm revealed the following: Regular sinus rhythm, left axis deviation, PR interval measures 0.20 seconds (within the upper limit of normal), QRS com-

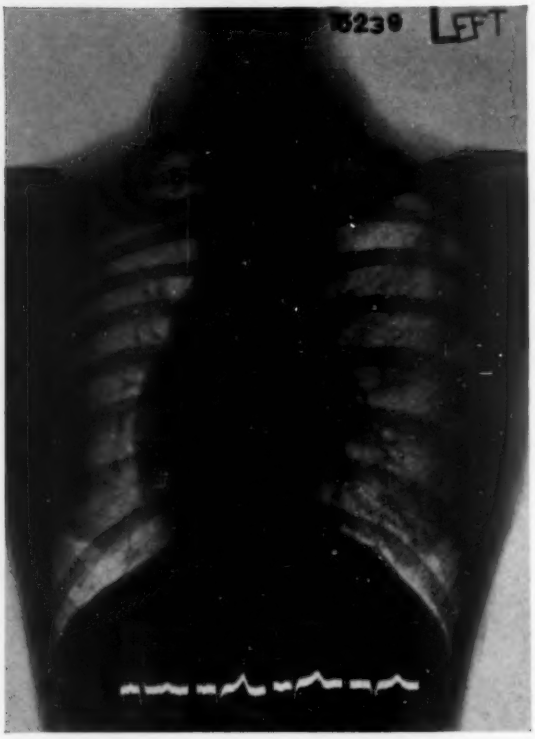

Fig. 4. Case III. Conventional roentgenogram showing displacement of the heart into the right thorax. Electrocardiogram showed regular sinus rhythm with moderate Q waves. These findings are due to cardiac rotation.

plexes are biphasic in all leads. P_3 and T_3 are inverted. The downward deflection of all complexes in lead I and the interchange of leads II and III indicates a mirror-image type of dextrocardia. Biphasic QRS complexes are seen in congenital heart disease or in cardiac rotation. The other changes suggest left ventricular enlargement or a transverse position of the heart. *Phonocardiogram:* There is present a high-pitched systolic murmur of large amplitude over the entire precordium. It is of greatest amplitude in the region of the second intercostal space to the right of the sternum. It is transmitted to the right shoulder and jugular notch.

Clinical Course. During the first week after admission the patient's temperature varied from 98.6 to 102° F. Ten days after admission signs of pneumonia in the left lower lobe were elicited. Sulfathiazole was ineffective in reducing the temperature but sulfapyridine was successful. There was no significant change in the blood cultures. The temperature remained at low levels but fluid developed at the left base which was aspirated. Culture of the pleural fluid was sterile. Administration of sulfathiazole was resumed. Blood cultures became negative five weeks after admission and remained so. Two months after admission the patient suffered another febrile episode. There was evidence of pneumonia or infarction in the right lower lobe with pleural effusion. Sulfathiazole was resumed. The patient again became afebrile. She continues to take 3 grams of sulfathiazole every day. The patient was last seen six months after the bacteriemia disappeared, apparently well.

Clinical Diagnosis. Subacute bacterial endocarditis (*Staphylococcus aureus*); pulmonary infarctions; patent ductus arteriosus.

Angiocardiography. Preliminary roentgenogram revealed the heart to be in the right chest. The heart appeared enlarged in its transverse diameter. The angiocardiogram showed dextrocardia of a "mirror-image" type. The various chambers were in normal relation to each other and to the liver and spleen. The right side of the heart appeared somewhat enlarged. The pulmonary artery was slightly dilated. The left ventricle was distinctly dilated. The aorta was of normal caliber.

Case II. Dextrocardia—Type III.

J.G. (No. 471846). White female, aged twenty-two. Since early childhood the patient had shown dextrocardia. She was always moderately dyspneic on exertion. In 1939 she suffered from marked dyspnea, swelling of the feet and loss of 25 lb. in weight. For this a subtotal thyroidectomy was performed elsewhere. She remained well following the operation, until the present illness.

Present Illness. Four weeks before admission the patient complained of pain in the legs with swelling of legs, knees and ankles. These symptoms varied in intensity and later were accompanied by pain and swelling in the hands.

Physical Examination. The patient was a well-developed and well-nourished girl. Significant physical findings were limited to the heart. Two cardiac impulses were felt, one in the fifth right intercostal space in the midclavicular line, the other just to the right of the sternum. Heart sounds were heard best to the right of the sternum in the second and third intercostal spaces. A faint systolic murmur was heard in the second intercostal space to the right of the sternum. Blood pressure 98/58, after exercise 145/54.

Laboratory Data. Hemoglobin 86 per cent, leukocytes 6,200, differential count normal, sedimentation rate one hour, basal metabolic rate −19 per cent. *Electrocardiogram:* Regular sinus rhythm, peculiar axis deviation, small Q 1, 2, 3, 4. QRS complex measures 0.11 second. These changes could be variously interpreted as representing impairment of the conduction system or functional disturbance without organic disease. Small Q and S waves are frequently seen in association with cardiac rotation.

Clinical Diagnosis. Isolated dextrocardia. No organic disease of the heart.

Angiocardiography. Preliminary roentgenographic examination showed the heart displaced to the right. It was difficult to identify the apex impulse but it appeared to be on the left. Rotation of the patient into the left oblique position revealed a cardiac contour corresponding to that usually seen in an exaggerated left oblique position. The angiocardiograms revealed a normal arrangement of the cardiac chambers, the heart being displaced to the right as a whole and rotated so that the left ventricle was situated anteriorly. No other abnormalities were demonstrated.

Bronchogram showed no abnormality in the lower lobe bronchi.

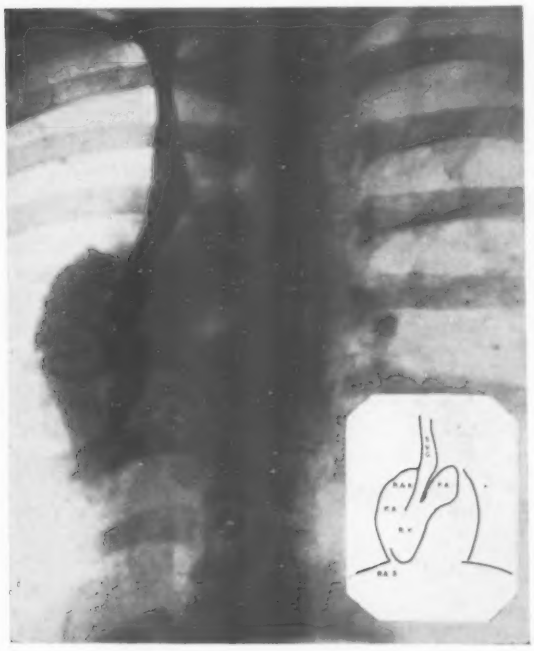

Fig. 5. Superior vena cava, right ventricle and pulmonary artery are opacified on the right side.

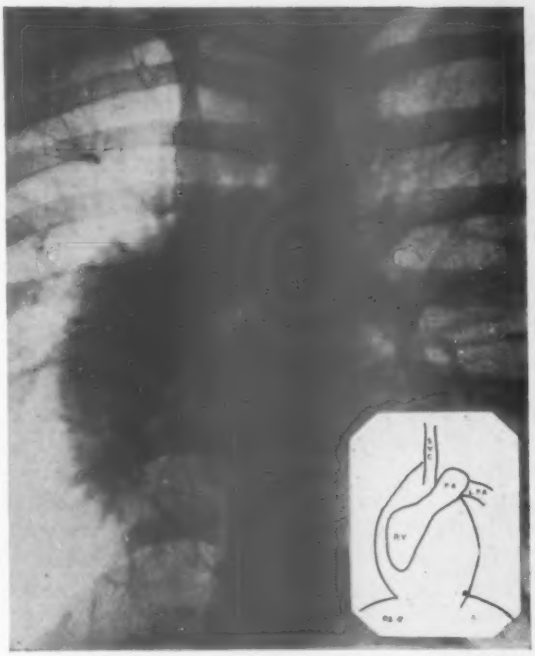

Fig. 6. Right ventricles and pulmonary arteries are opacified and are seen to be in normal relationship, confirming the diagnosis of dextrocardia Type III.

Case III. Dextrocardia—Type III.

R.A. (No. 468934). White female, aged twenty. For many years the patient complained of an intermittent dull pain in the lower left chest, exaggerated on deep inspiration. There was also tenderness on pressure. Dyspnea on exertion was present for many years.

Present Illness. One month before admission the patient suffered an upper respiratory infection at which time the chest pain was aggravated. Ten days before admission she suffered agonizing pain in the left chest which lasted for three days.

Physical Examination. The patient was an asthenic girl. The significant physical findings were limited to the chest. There was tenderness over the eighth and ninth ribs in the left anterior axillary line. No abnormal pulmonary signs were elicited. Cardiac dullness was percussed entirely in the right chest. Maximum pulsation was palpated in the fourth intercostal space in the right mid-clavicular line. There was a faint systolic murmur in the second intercostal space to the right of the sternum. Blood pressure 110/70 in the arms, 150/100 in the legs.

Laboratory Data. Hemoglobin 85 per cent,

leukocytes 10,600, with 79 per cent segmented polymorphonuclears. Urine showed an occasional leukocyte. *Electrocardiogram:* Regular sinus rhythm. Q1, Q2, Q3 and Q4 were small. No other abnormalities were demonstrated. These findings are sometimes associated with cardiac rotation.

Clinical Diagnosis. Isolated dextrocardia; upper respiratory infection; pleurodynia.

Angiocardiography. Preliminary roentgenographic examination showed the heart displaced to the right. It was difficult to identify the apex impulse but it appeared to be on the left. Rotation of the patient into the left oblique position revealed a cardiac contour which corresponded to that usually seen in an exaggerated left oblique position. The angiocardiogram revealed a normal arrangement of the cardiac chambers, the heart being displaced to the right and rotated so that the left ventricle was situated anteriorly. No other abnormalities were demonstrated.

Bronchogram showed no abnormality in the arrangement of the lower lobe bronchi.

CONCLUSIONS

The diagnosis of dextrocardia with complete or partial transposition of viscera presents no diagnostic difficulties. However, differentiation of the type of isolated dextrocardia in which there is inversion of the cardiac chambers from that type with a normal arrangement of the chambers may be very difficult. Angiocardiography affords a method of making this differentiation during life. Cases of Types I and III studied in this way are reported. A Type II case has not been available for study. Admittedly this type is rare, and in fact doubt has been thrown on the authenticity of many of the reported cases because of the absence of confirming postmortem studies.

ADDENDUM: Since the manuscript was submitted, we have studied another case of dextrocardia Type I, with a most unusual variation—a persistent left aortic arch. The presence of the aortic knob to the left of the spine on the conventional posteroanterior roentgenogram caused considerable diagnostic confusion. Angiocardiography revealed a normal heart with a persistent right aortic arch, but in mirror image.

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PLEURAL LESIONS IN HEMOPHILIA*

REPORT OF A CASE

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PATIENTS with hemophilia are relatively rare in radiologic practice, even in a large teaching hospital. Recently, in a patient with hemophilia we observed shadows in the roentgen examination of the chest that to us were unique (Fig. 1 and 2). One of these shadows was round and located in the left lower chest (Fig. 1). The other was oval and was situated in the left upper thorax along the lateral chest wall (Fig. 2). We inquired among our medical and pathological colleagues for an explanation of these shadows, but none with whom we corresponded had ever observed a similar condition in a patient with hemophilia. It has therefore seemed appropriate to report the observation with the hope that others may be stimulated to make similar studies and that the cause of the shadows may be determined.

During the past five years several authors have listed the known causes of round and discrete shadows in the lung fields. Fruchter[4] and Gallavresi[5] have covered the differential possibilities quite thoroughly without mentioning hemophilia as a possible cause or without mentioning the necessity of differentiating small loculated interlobar collections from true parenchymal lesions. Hirsch[6] added polycythemia vera as a cause of rounded shadows in the lung fields, and the lung changes are explained as being due to hemorrhage or to a localized congestion with diapedesis of erythrocytes. Hodes and Griffith,[7] in a paper on polycythemia associated with arteriolosclerosis, describe shadows which occur in that disease and state that the shadows are possibly due to rupture of a vein proximal to a thrombus with resulting perivascular hemorrhage.

Apparently lung changes of any form are most uncommon in true hemophilia. Brugsch[2] reviews the literature on this disease up to 1939 but does not report on any lung changes. Schloessmann,[8] in a classic monograph on hemophilia, devotes one small paragraph to the lung changes. He states that pulmonary hemorrhages have been reported as occurring but does not quote from what source the information was obtained. He also states that although most forms of serosal hemorrhage are not infrequent in hemophilia, spontaneous hemothorax is generally unknown.

CASE REPORT

L. S., white male, aged twenty-four, was admitted to the Hospital of the University of Pennsylvania with a chief complaint of hematuria of three days' duration.

Past Medical History. As a baby the patient underwent ritual circumcision without any untoward bleeding. His first severe hemorrhage occurred at the age of four, following tonsillectomy. This necessitated hospitalization for eight weeks. Since that time the patient has had frequent severe hemorrhage from minor cuts and injuries. In 1921 he had three severe episodes, bleeding from a tooth socket after an extraction, a hemarthrosis of the right knee following a fall, and bleeding from a laceration of the tongue. In 1923 he received a cut over the right eye which bled so profusely that two transfusions were required. Episodes were then relatively minor until 1930 when the right knee was once again the site of a hemarthrosis. In 1934 the right ankle was injured with resulting hemarthrosis.

In February, 1936, when arising from a chair, the patient was suddenly seized with a sharp and severe pain in the left chest. He was taken to the Jewish Hospital of Philadelphia. On arrival he was unconscious and remained coma-

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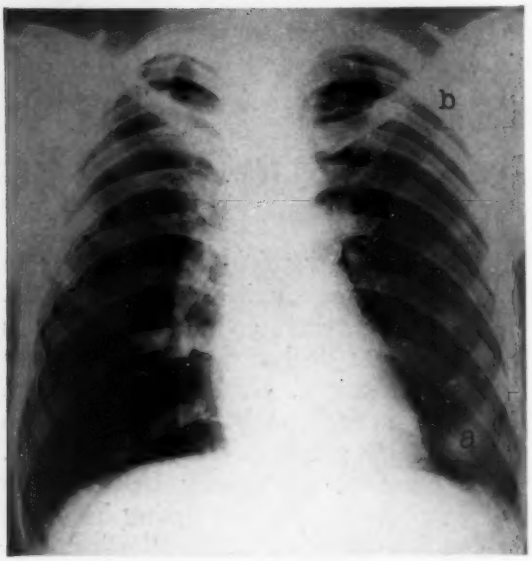

Fig. 1. Roentgenogram of chest of a patient with hemophilia. January 25, 1938. The right lung is negative. On the left side there is a shadow at *a* and at *b*. The shadow at *b* is obviously pleural, the one at *a* may be a localized pleural hemorrhage.

tose for about one week. A diagnosis of hemothorax was made at the Jewish Hospital. During a stay in the hospital of two months his left pleural space was tapped on two occasions, pure blood being obtained each time. Twenty-three transfusions were given during the period of hospitalization. In spite of these repeated transfusions his weight fell from 135 pounds to 92 pounds and his hemoglobin was as low as 49 per cent. The patient states that following this spontaneous hemothorax he has never felt strong, has frequent palpitation, and becomes short of breath very easily.

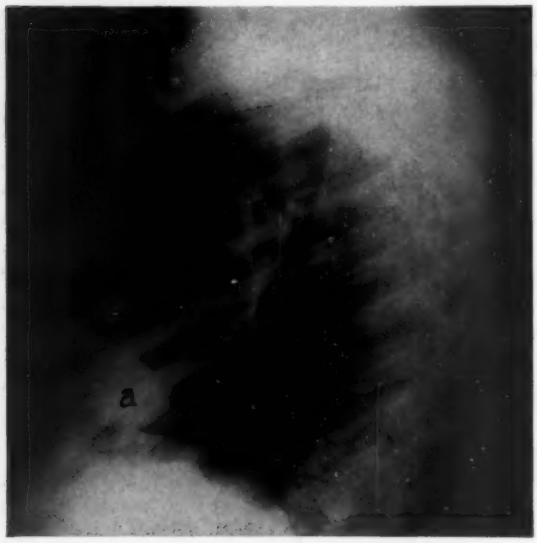

Fig. 2. Lateral view made January 25, 1938. The round shadow at *a* is near the line of the interlobar fissure.

Family History. Father, mother, one brother, and one sister are free from any bleeding tendency. A maternal grandfather is supposed to have died from hemophilia. Two male cousins on the mother's side have a definite hemorrhagic tendency.

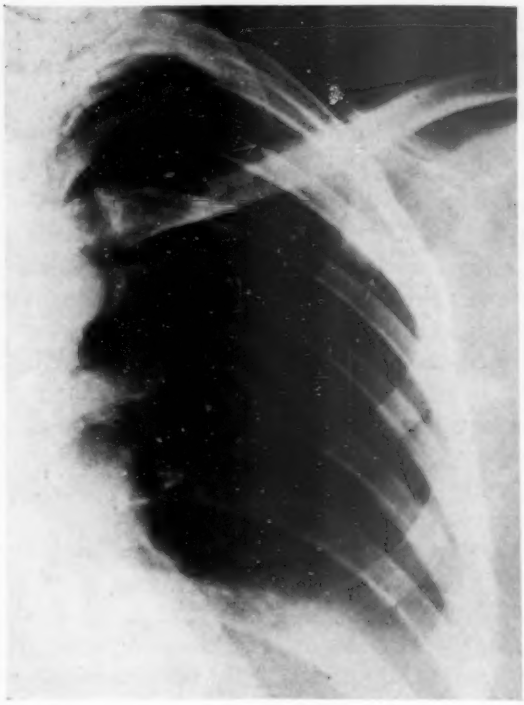

Fig. 3. Close up of the pleural shadow in the left upper chest. January 25, 1938.

Present Medical History. In January, 1938, three days before admission to the Hospital of the University of Pennsylvania, the patient developed painless hematuria. He had no other symptoms and felt quite well.

Physical examination on admission to the hospital disclosed only the following positive findings: chest percussion note over the left hemithorax was slightly impaired anteriorly, and over the same area the breath sounds seemed somewhat distant. No joint disability was noted.

Laboratory examinations disclosed urine with

red blood cells, the erythrocyte count was 4,600,000 and the white blood cells numbered 12,000. There were 316,000 platelets. The bleeding time was one minute and the coagulation time was one hour and thirty-five minutes.

The patient was studied on the ward and one small transfusion was given which arrested the painless hematuria. During the stay in the hospital, roentgen examinations were made of the right knee and of the chest.

The roentgen examination of the chest on January 25, 1938, showed the following: The

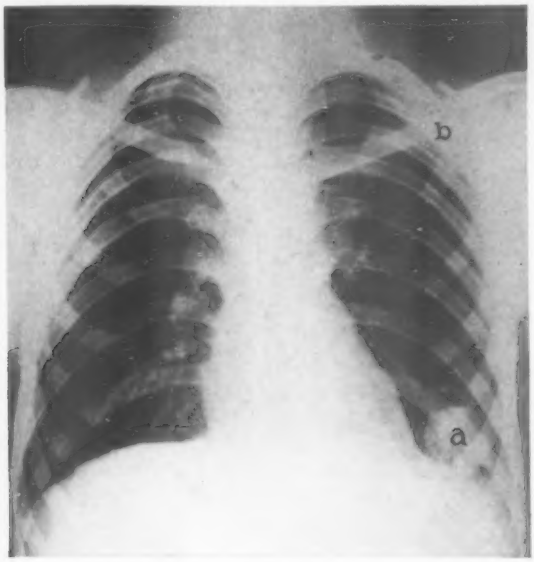

Fig. 4. Roentgenogram taken in April, 1941, of same patient as shown in Figure 1. The shadows at *a* and *b* are smaller. Compare with Figure 1.

right lung field is negative (Fig. 1). On the left there are two shadows; one in the lower portion of the thorax seen at *a* in Figures 1 and 2; the other is seen at *b* in Figure 1, and is outlined by arrows in Figure 3. The shadows *a* and *b* are regarded as being due to a localized hemothorax. The lesion seen at *a* in Figures 1 and 2 is such that it might be due to an interlobar collection.

The patient has returned, by request, for several re-examinations, the last being in April, 1941. The patient has remained quite well since his discharge from the hospital in February, 1938. The roentgen examination of the chest on April 23, 1941, revealed the following: The right lung field is negative. On the left, the shadow at *a* in Figures 4 and 5 is much smaller than that seen in Figures 1 and 2. The shadow

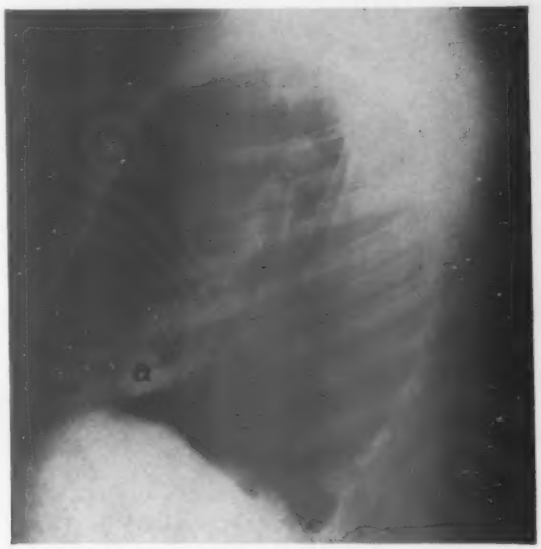

Fig. 5. Lateral view made in April, 1941. The shadow at *a* is smaller. Compare with Figure 2.

seen in Figure 6 is smaller and is flatter on the lung side than that seen in Figure 3.

Fig. 6. Close up of the pleural shadow in the left upper chest. April, 1941. The shadow is smaller. Compare with Figure 3.

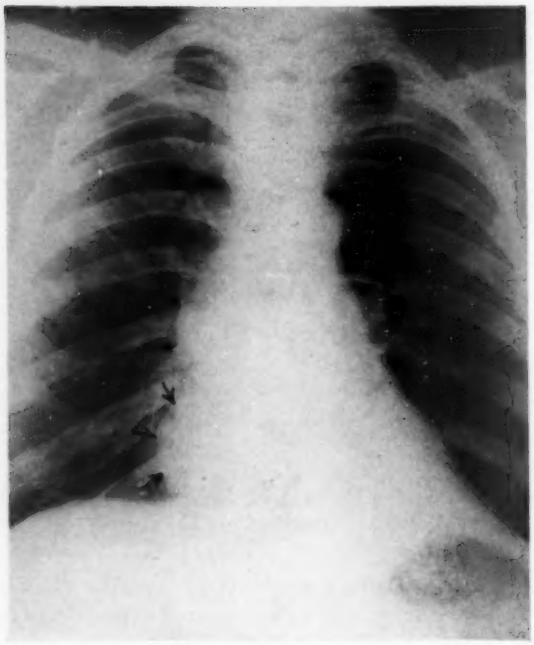

Fig. 7. A pleural hemorrhage producing rounded shadows simulating tumors. The patient was an adult male who, after being thrown over the head of a horse, had a slight hemoptysis. The roentgenogram shows the lung fields to be clear. On the right side of the mediastinum there are shadows that look like two lobulated lesions. They are well defined. These lesions were at first thought to be evidence of mediastinal lymphoma.

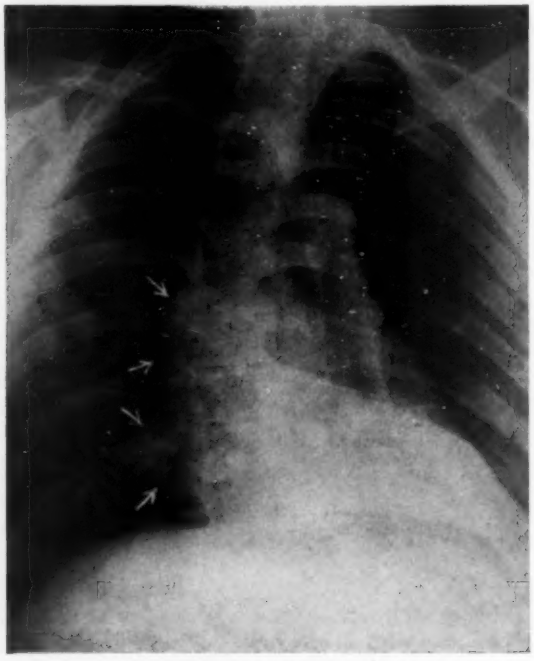

Fig. 8. Same case as Figure 7. An oblique view showing the rounded shadows to somewhat better advantage. These lesions were regarded as a hemothorax that was localized in the mediastinal pleura. The shadows disappeared after the patient recovered.

DISCUSSION

We believe that the shadow along the left lateral chest wall seen in Figure 3 is pleural in origin. The identity of the shadow seen at *a* in Figures 1 and 2 is not so certain. There is a history of a hemothorax in February, 1936, and although nearly five years have elapsed since the patient's original chest complaint, we feel

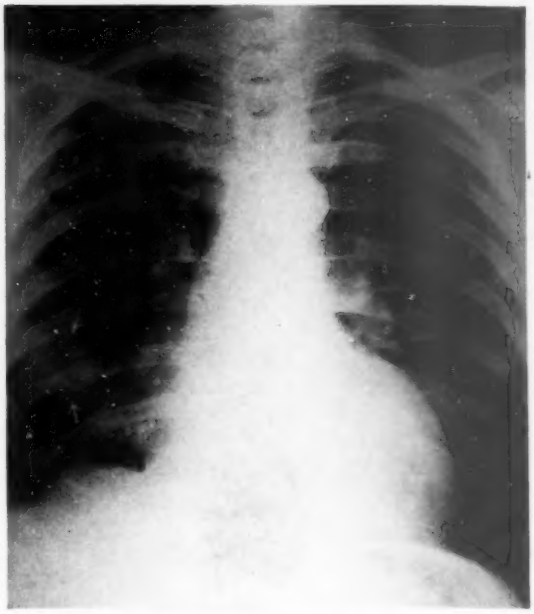

Fig. 9. Encysted and localized hydrothorax of the interlobar fissure on the right side producing a round shadow simulating that produced by a lung tumor. At the time of the roentgen examination the patient was forty-nine years old and because of the rounded shadow in the right lung field he was referred for roentgen therapy as the lesion was diagnosed as a primary tumor of the lung.

that there is a strong possibility that both of the shadows may represent the residual roentgen evidence of the previous pleural involvement. We have observed the patient during two years of that period, and the shadows are disappearing very slowly

(compare Fig. 1 and 4). If the lesion seen at *a* in Figure 1 was due to hemorrhage in the lung parenchyma, it is believed that the evidence of it would have disappeared long before the examination made in April, 1941.

If the round shadow is pleural in origin, this case report should serve to emphasize the necessity for roentgenologists to bear in mind the fact that pleural conditions (a localized interlobar collection or hemorrhage) *may produce a shadow that simulates a parenchymal lesion.* We have seen round shadows due to hemorrhage into the pleura (following trauma to the chest wall) that were diagnosed incorrectly as a lung tumor (Fig. 7 and 8). On at least two occasions we have seen round pleural shadows due, in each instance, to a localized pleural transudate in an interlobar fissure (in a patient with a decompensating heart) which we diagnosed and treated as cancer of the lung until we learned the true nature of the lesions (Fig. 9 and 10). Encapsulated lesions in the interlobar fissures, which simulate the shadows of lung tumors, have been described and reported by Austrian[1] and Freedman.[3]

Fig. 10. Same case as Figure 9. The rounded shadow in the right lung has disappeared. The lesion disappeared after roentgen therapy on two occasions before we learned that the lesion was secondary to a cardiac condition. As the cardiac decompensation improved the interlobar collection would disappear.

SUMMARY

A case of typical hemophilia is reported in which the roentgen appearance of an interlobar hemorrhage in the left lower chest simulates a parenchymal lesion. Illustrations of a mediastinal pleural hemorrhage and an interlobar transudate are shown to demonstrate how other pleural conditions may likewise produce shadows on a roentgenogram that simulate those produced by tumors.

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PLEURAL EFFUSION AND ASCITES IN ASSOCIATION WITH FIBROMA OF THE OVARY (MEIGS' SYNDROME)*

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A PATIENT presenting herself with a tumor in the pelvis, ascites, and pleural effusion would in all probability be diagnosed as suffering from a malignant neoplasm with metastatic involvement. The condition would probably be considsidered inoperable and a hopeless prognosis given. Meigs and Cass, however, called attention to a group of patients with the above findings in which the pelvic mass was found to be a fibroma. They further pointed out that following operative removal of the growth, the fluid disappeared and a complete cure was effected. This condition has been termed Meigs' syndrome by several authors. Although the use of proper names to indicate clinical conditions is looked on with disfavor, no single term adequately describes this group of findings. It therefore appears that "Meigs' syndrome" has established itself in the literature and will continue to be used in the future.

To the roentgenologist this condition is of special interest. Pleural effusion is routinely diagnosed by roentgen studies, and the etiology is always of immediate concern. The many causes of fluid in the chest cavity must be constantly borne in mind and the possibility of Meigs' syndrome should be considered in all obscure cases. If the condition is recognized, a favorable prognosis can be given. With an incorrect diagnosis of malignant disease, the patient is subjected to needless suffering, both mental and physical, many tappings of the pleural and peritoneal cavities are necessary, and radiation therapy, which is not indicated, may be administered.

According to Meigs' most recent report, only 17 cases of the syndrome are on record in the literature. It appears, however, that this condition is relatively common and there are doubtless many unrecognized cases in existence. We have therefore deemed it worth while to discuss the clinical manifestations in some detail and to record 2 additional instances which have recently come under our observation. In the first patient, the diagnosis has been confirmed by the pathologic findings and the patient was completely cured by operation. The second case has been observed over a period of several years with typical roentgen and clinical findings, but the patient has refused surgical intervention because of her advanced age.

REVIEW OF THE LITERATURE

The fact that ascites may occur with various pelvic tumors such as large fibroids, cysts, adenofibromas, cystadenomas and granulosa cell tumors is generally well known. Also, that these neoplasms may occasionally give rise to pleural effusion has been mentioned in the older literature. Collingsworth[2] in 1879 reported a case which died without operation and was found at postmortem examination to have a left pleural effusion and bilateral ovarian fibromata. Hoon,[5] Leo,[6] Frank,[3] McIrath,[9] and others,[7,14,16,17] have also recorded instances of the syndrome. In 1934, Meigs[10] cited 3 cases of pleural fluid associated with fibroma of the ovary and another was discussed the following year in "The Case Records of the Massachusetts General Hospital." Meigs and Cass[13] in 1937 collected 7 cases. Rhoads and Terrell[15] presented 2 additional instances, stressed the fact that this condition constituted a definite clinical entity, and suggested that

* From The Pondville Hospital, Massachusetts Department of Public Health and the Department of Roentgenology of the Boston City Hospital. Presented before the New England Roentgen Society, March 21, 1941.

it should be called a syndrome. Other cases have recently been recorded by Weld,[19] Schenck,[18] Harris and Meyer,[4] and MacFee.[8]

ETIOLOGY

The reasons for the formation of the effusion in the pleural space are not known. No satisfactory explanation of the phenomenon has been offered by any of the writers on this topic. Normally, there exists no anatomic connection between the pleura and the peritoneum. In pneumoperitoneum, no air finds its way into the pleural space, nor do patients with pneumothorax develop air in the peritoneal cavity. Congenital defects in the diaphragm could account for the syndrome. If this were the cause, drainage of the ascitic fluid would simultaneously empty the pleural space, which usually does not occur. Other possible explanations include circulatory phenomena, hormonal effects and peritoneal irritation due to the fibroma acting as an irritant or shock agent. Changes in the circulation probably due to back pressure appear to be the most logical explanation at present, although the mechanism of the syndrome must await further study.

The youngest patient in the reported cases was thirty-six and the oldest seventy years old. The condition is most common in the fourth and fifth decades of life. Marital status does not appear to be an important factor, cases having been recorded in both single and married women. Similarly, there is no apparent relation to fertility or sterility since the syndrome occurs in the childless as well as in those who have borne one or more children.

CLINICAL SYMPTOMS AND PHYSICAL SIGNS

The condition may be easily overlooked as there is no typical or pathognomonic clinical symptomatology. In some instances, the complaints are due solely to the presence of the pleural fluid causing dyspnea, orthopnea, cough, and pain or a feeling of discomfort in the chest. There may be nothing to call attention to the presence of the ovarian fibroma and unless the possibility of the syndrome is borne in mind, the diagnosis will be missed. In other patients, the symptoms are associated solely with the ascites and the mass. There may be a sense of pressure or weight in the pelvis and abnormal bleeding. Swelling of the abdomen and edema of the legs result from the increasing quantities of fluid. Loss of weight, anemia and cachexia may be present. Gastrointestinal complaints are frequent and consist of bloating, belching, nausea, and poor appetite. Disturbances of the menses may occur and include metrorrhagia, dysmenorrhea, and amenorrhea. The complaints may be of very recent origin; in other instances, the symptoms have persisted for many years.

On physical examination, the patients are usually well nourished and may appear surprisingly well in spite of the complaints. If cachexia is present, it apparently results from the dehydration consequent upon the rapid development of the ascites and pleural effusion. The fluid in the chest is usually demonstrable without difficulty by the routine clinical and roentgen studies. The signs of the ascites are more variable and may be extremely difficult to elicit. Similarly, the pelvic mass may be demonstrated only with considerable difficulty and may be overlooked even on careful examination. At times, removal of the ascitic fluid is necessary to outline the fibroma. The tumor and fluid have been known to be present as long as eight years. The mass may be small or large, tumors 20 cm. in diameter having been reported.

The fluid removed from the pleural and peritoneal cavities is a transudate with a specific gravity of about 1.015 and does not contain tumor cells, tubercle bacilli, bacteria or blood elements. The effusion tends to recur promptly and in considerable quantities after tapping. There is usually no elevation of temperature. The white count and serum protein are normal or nearly so. Anemia is not present, although bleeding may cause varying degrees of changes in the blood picture.

PATHOLOGY

The tumors are fibromas or fibromyomas and may apparently arise from any of the elements of the ovary, but most frequently originate from the connective tissue stroma. Cystic areas may be present and necrosis is common. Calcification ordinarily does not occur within these masses. The size of the mass is variable and some attain very large proportions as indicated above. There appears to be no definite relation between the size of the neoplasm and the location or quantity of the fluid. The effusion may occur on the same side as the mass or on the contralateral side; unilateral masses may be found with bilateral effusions; and patients with fibromas in both sides of the pelvis may present fluid in one or both sides of the chest. The fluid does not recur after the removal of the pelvic tumor.

ROENTGEN FINDINGS

The roentgen examination of the chest is of value in demonstrating the fluid and its rate of accumulation. Studies immediately after the removal of the fluid are indicated to rule out cancer of the lung or pleura, tuberculosis, heart disease or other possible causes of effusion. Films of the abdomen and pelvis usually do not demonstrate the ascites or the fibroma unless calcification is present in the tumor, which is rarely the case. Examination of the small bowel after the oral administration of an opaque meal may show characteristic changes in the intestinal pattern with large amounts of fluid in the abdomen; also, if the pelvic mass has attained considerable size the small bowel shows upward and lateral displacement, which may be of value in outlining the size of the fibroma. Uterosalpingography with iodized oil demonstrates displacement and narrowing of the uterus due to extrinsic pressure by the pelvic mass and may be of importance in ruling out uterine neoplasm.

TREATMENT

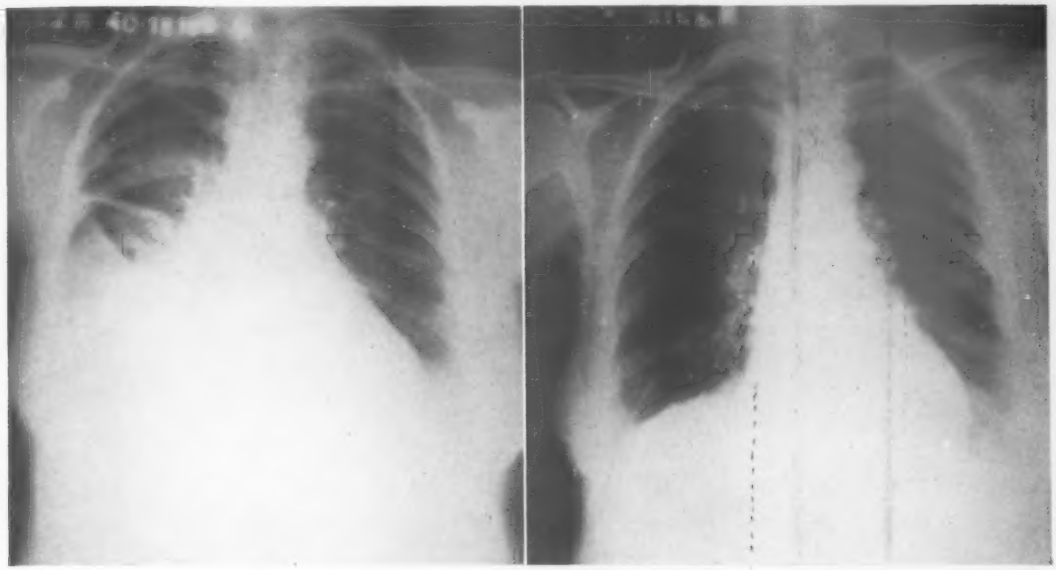
Medical therapy is supportive and palliative but is unavailing in the production of a cure of this condition. Repeated tappings are required and the patient may live for many years in a state of partial or complete invalidism. The pelvic mass tends to enlarge gradually, causing greater discomfort with a sense of weight and pressure in the abdomen and pelvis. The disease is usually slowly progressive and death may ensue from increasing cachexia, dyspnea and finally general collapse.

Operation is indicated in Meigs' syndrome as soon as the diagnosis is established, as removal of the mass produces a permanent cure. There have been no reported fatalities or unusual postoperative complications. Removal of the tumor offers no particular difficulties. Occasionally the chest must be tapped one or more times after the operation for removal of residual fluid. In most instances the fluid disappears spontaneously postoperatively and does not recur. Radiation therapy is not indicated.

CASE REPORTS

Case 1. (Pondville Hospital No. 18166) M. M. D., female, aged fifty-seven. Patient was admitted to the Pondville Hospital on December 8, 1940, complaining of a feeling of pressure in the lower portion of the abdomen. This had begun several months previously and had gradually increased; it was not severe and never became worse than a dull pain. There was also a sensation that the pelvic organs were dropping and moderate vaginal protrusion after being on her feet a long time. There were no bladder or rectal disturbances and no abnormal bleeding or discharge. She had been moderately dyspneic but had not coughed or raised sputum. The menopause had taken place about ten years before. She had lost about 20 pounds during the past two months.

On physical examination, there was a slight edema of the legs and ankles, more on the right side. The blood pressure was 160/100. The chest examination revealed decreased resonance and breath sounds at the right base. The heart was normal. The abdomen was distended in its lower half. An irregular, nodular, somewhat movable mass about 3 or 4 inches in diameter was palpable in the suprapubic area; the uterus was large and appeared continuous with the pelvic tumor. On vaginal examination, there



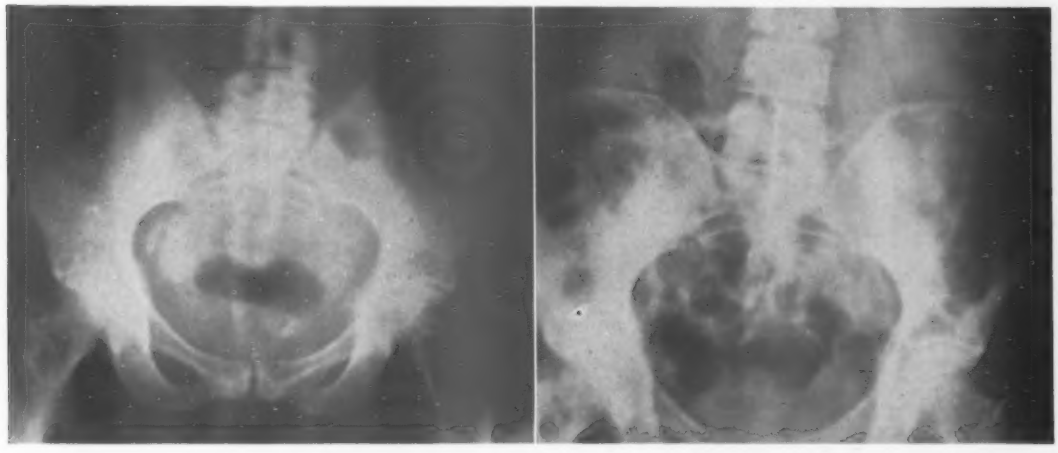
A *B*

FIG. 1. Case 1. *A*, roentgenogram of the chest prior to operation showing fluid at the right base and in the interlobar septum. At thoracentesis, 800 cc. of fluid was obtained. *B*, roentgenogram of the chest about three weeks after operation. The fluid disappeared spontaneously.

was a second degree cystocele and a first degree uterine prolapse. A pedunculated, firm fibroid about ½ inch in diameter protruded from the external os, and this was removed two days after admission to the hospital.

On December 11, 1940, roentgen studies of the chest revealed fluid at the right base and in the interlobar septum between the middle and lower lobes. At thoracentesis, 600 cc. of thin, blood-tinged fluid was removed.

Roentgenograms of the pelvis revealed increased soft tissue density occupying the entire pelvis, with a rounded, irregularly calcified shadow about 4 cm. in diameter in the right



A *B*

FIG. 2. Case 1. *A*, roentgenogram of the pelvis before operation. The pelvis is occupied by a soft tissue mass which displaces the intestines upward. An irregular area of calcification is visible in the superior portion of the pelvis on the right side. *B*, after removal of the pelvic tumor, numerous gas-filled loops of intestines are visible throughout the pelvis.

side of the pelvis, consistent with a calcification in the right ovary.

The chest was again tapped on December 24, 1940, and 1,000 cc. of fluid removed; this showed no tumor cells. Fluid was present in the abdomen, as well as the mass previously described, but paracentesis was not done.

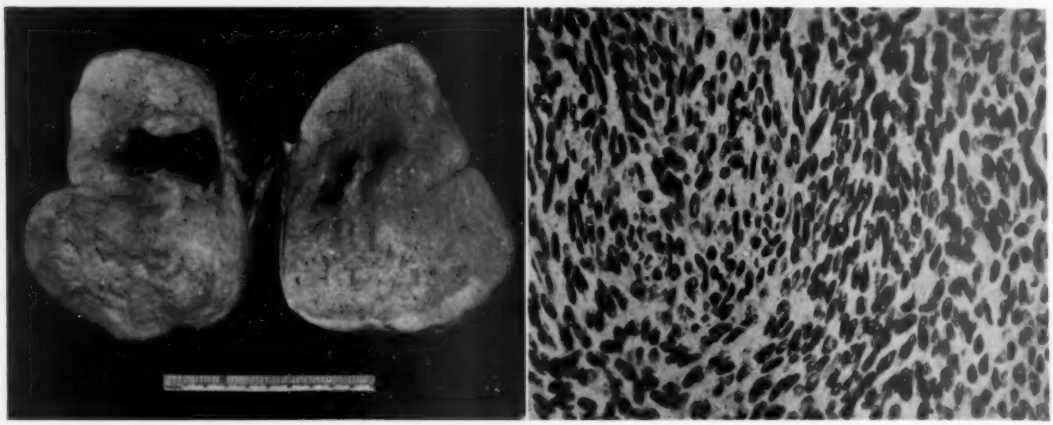
Operation was performed on December 31, 1940, and about 2 quarts of fluid was drained from the abdomen. A large mass which filled the entire lower pelvis was extirpated. The tumor was firm, white, rounded and closely connected to the uterus; it measured about 12 cm. in diameter. The right ovary was replaced by a solid, hard tumor and was removed. Total hysterectomy was performed.

Postoperative convalescence was uneventful. Ten days after operation, the lungs were clear to physical examination. Roentgen studies revealed only a small amount of fluid in the right pleural space with a slight prominence in the hilar regions; otherwise the lung fields were clear. Twelve days later, the roentgen studies were repeated. The lung fields were entirely clear and there was no sign of fluid. Films of the pelvis showed no opaque shadows and gas-filled loops of the intestine were noted low in the pelvis.

The pathologic report was as follows: The left ovary was greatly enlarged, measuring 16 by 11 by 8 cm.; the right measured 5 by 6 by 3 cm. and was composed of a cystic cavity containing thick fluid and a thin wall which was hard and partially calcified. Diagnosis: fibroma of the left ovary, and hemorrhagic cyst of the right ovary with ossification.

The patient was discharged well and free of complaints.

Case 11. (Boston City Hospital No. 941622) S. G., female, aged seventy. The patient has known that she had a large pelvic mass for over five years and has refused operation because of her advanced age. She has felt well except that the abdomen had become large and protruber-



A *B*

Fig. 3. Case 1. *A*, photograph of the tumor removed at operation. *B*, photomicrograph of a section of the fibroma of the ovary.

ant. She has had no pain, frequency or dysuria. Dyspnea has been present for over two years and was increasing.

She first entered the Boston City Hospital on May 27, 1939, for tapping. On physical examination, there was dullness over the whole right chest with absence of fremitus and breath and voice sounds. The heart was displaced to the left; the sounds were normal and no murmurs were heard. The abdomen was markedly distended and shifting fluid was demonstrable. A large mass was palpable rising from the pelvis into the mid-abdomen. The day after admission, 1,200 cc. of turbid fluid was removed from the right chest. The specific gravity of the fluid was 1.012 and no tumor cells were found. The abdomen was tapped and 6,500 cc. of fluid drained, after which a large pelvic tumor rising to the level of the umbilicus could be clearly outlined.

The urine was negative; hemoglobin 13.1; erythrocyte count 3,900,000; leukocyte count 9,800; Hinton test negative; non-protein nitrogen 34.

The chest was again tapped three days later and 1,300 cc. of fluid was obtained.

In June, 1940, about one year later, the patient re-entered the hospital for relief of abdominal distention and dyspnea. At this time 10 liters of fluid with specific gravity of 1.020 was removed from the abdomen.

On August 1, 1940, the patient was again admitted complaining of progressive increase in the size of the abdomen, dyspnea, and edema of the legs; 1800 cc. of fluid was removed from the right chest; the specific gravity was 1.012. Ten quarts of fluid were drained from the abdomen; the specific gravity was 1.022.

When last heard from, the patient was under the care of her family physician. The fluid continued to re-accumulate rapidly and required frequent removal. The patient was in a state of semi-invalidism, but would not consent to operation.

SUMMARY

Meigs' syndrome is the occurrence of pleural effusion and ascites in association with fibroma of the ovary.

The syndrome is of particular interest to the roentgenologist because the condition may easily be diagnosed as cancer with metastatic involvement, and a hopeless prognosis given.

The reasons for the formation of the fluid are not understood. The fluid is a transudate with a specific gravity of about 1.015.

The fluid recurs promptly after tapping and medical treatment is without effect.

Operative removal of the pelvic mass effects a complete and permanent cure and the fluid does not recur after operation.

Radiation therapy is not indicated.

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GASTRIC AND DUODENAL ULCER ASSOCIATED WITH LESIONS OF THE LOWER END OF THE ESOPHAGUS AND THE CARDIA OF THE STOMACH

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OUR file of benign lesions of the alimentary tract at or near the diaphragm shows a surprisingly high incidence of associated ulceration either in the stomach or duodenum.

The literature on this subject seems meager.

Bokor,[2] in 1926, noted 1 case of asymptomatic, small esophageal diverticulum associated with a duodenal ulcer. He raised the question as to the relationship since these two conditions can often be found together.

Harrington,[5] in 1930, gave an account of operations on 30 cases of diaphragmatic hernia, in 8 of which there had been hemorrhage from the stomach. In 7 of the 30 cases there was evidence of erosion or ulceration of the gastric mucosa at operation.

In 1930, Eusterman, Moersch and Camp[3] reported 3 cases of cardiospasm, 1 associated with a gastric ulcer.

In 1931, Mathews and MacFee[8] presented 2 cases where ulceration developed in a herniated portion of the stomach in diaphragmatic hernias. Anemia occurred in both cases.

Truesdale,[10] in 1932, reviewed the literature on diaphragmatic hernia. Apparently only 17 cases of gastric ulcer associated with diaphragmatic hernia had been encountered up to that time. Eighteen new cases were added. The ulcerations varied from a small niche to multiple perforating ulcers of large size.

Wilkinson,[11] in 1934, reported that in 70 cases of diaphragmatic hernia, associated esophageal or peptic ulcer was noted in ten.

Golden,[4] in 1936, published an illustration of a gastric diverticulum associated with a duodenal ulcer.

Jankelson and Morein,[6] in 1940, reported 3 cases of gastric ulcer associated with hiatus hernia.

Polley,[9] in 1941, presented a series of 14 cases of congenital short esophagus with thoracic stomach in which 1 had a duodenal ulcer. In 33 cases of esophageal hiatus hernia of the stomach there were 3 gastric ulcers and 2 duodenal ulcers.

Kelley, Lawlah and Berry,[7] in 1941, published an illustration of a gastric diverticulum with an incidental "clover leaf" deformity of the duodenal bulb.

Beilin,[1] in 1941, mentioned 3 cases of duodenal ulcer among various other associated pathologic conditions in a series of 26 cases of diaphragmatic hernia.

In our own series, there are 3 cases of hiatus hernia and 1 of para-esophageal hernia, all with ulcerations in the herniated portion of the stomach. One case of associated hiatus hernia and duodenal ulcer was observed. There were 2 practically identical instances of short esophagus with ulceration at the cardia. One of these also had an ulcer at the pylorus.

Each of 2 cases of diverticulum of the lower esophagus also had duodenal ulcer.

A single case of gastric diverticulum and duodenal ulcer was encountered.

Two most interesting cases were seen with mega-esophagus (cardiospasm). Both developed ulcerations, one just below the diaphragm, the second in the prepyloric region. Multiple large lower esophageal diverticula were present in the latter instance.

REPORT OF CASES

CASE 1. E. P., male, aged fifty-one. "Indigestion" almost continuously for two months, characterized by discomfort and pain coming on about 11 P.M. Relieved by sitting up or walk-

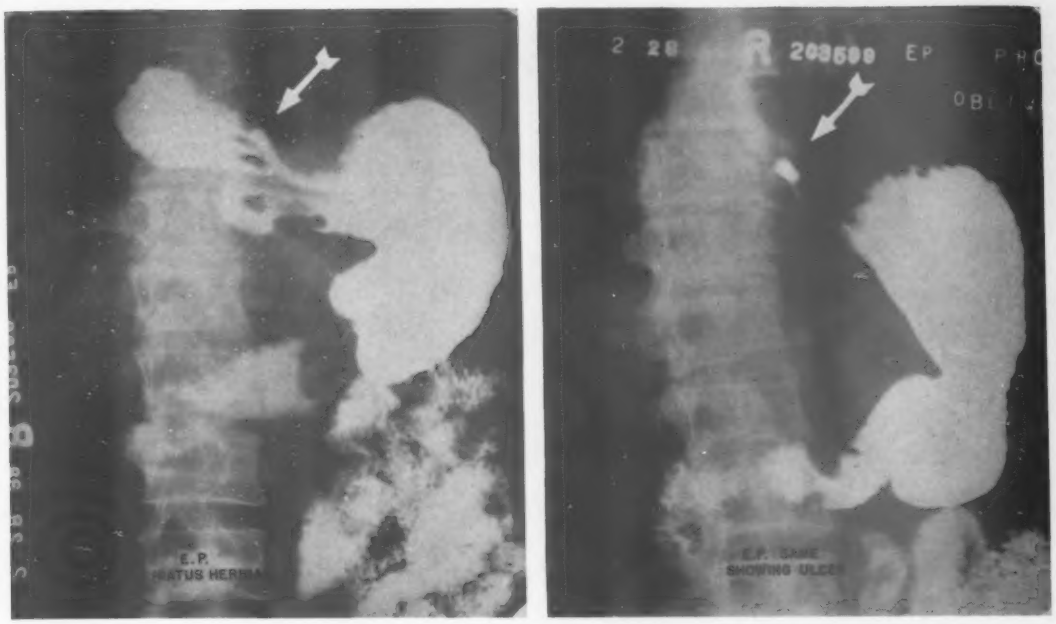

Fig. 1. Case I. Hiatus hernia with ulcer above hiatus. (Courtesy Dr. H. C. Maier.)

ing about. Eleven pounds loss of weight during this interval. Symptoms controlled since examination by modified Sippy diet.

Roentgen Findings. Hiatus hernia with ulcer above hiatus (Fig. 1).

Case II. M. O., female, aged sixty-four. Severe pain in epigastrium, coming on one-half hour after meals, of several months' duration. Pain relieved by lying down. Frequent vomiting.

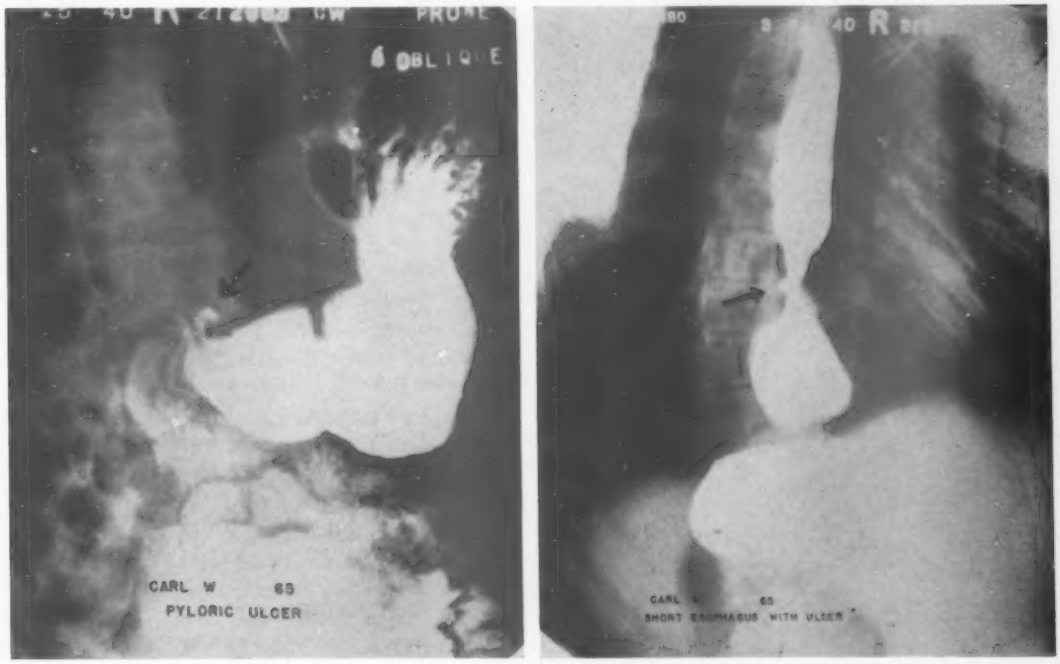

Fig. 2. Case VI. Short esophagus with ulcer at cardia (above hiatus) associated with ulcer at pylorus.

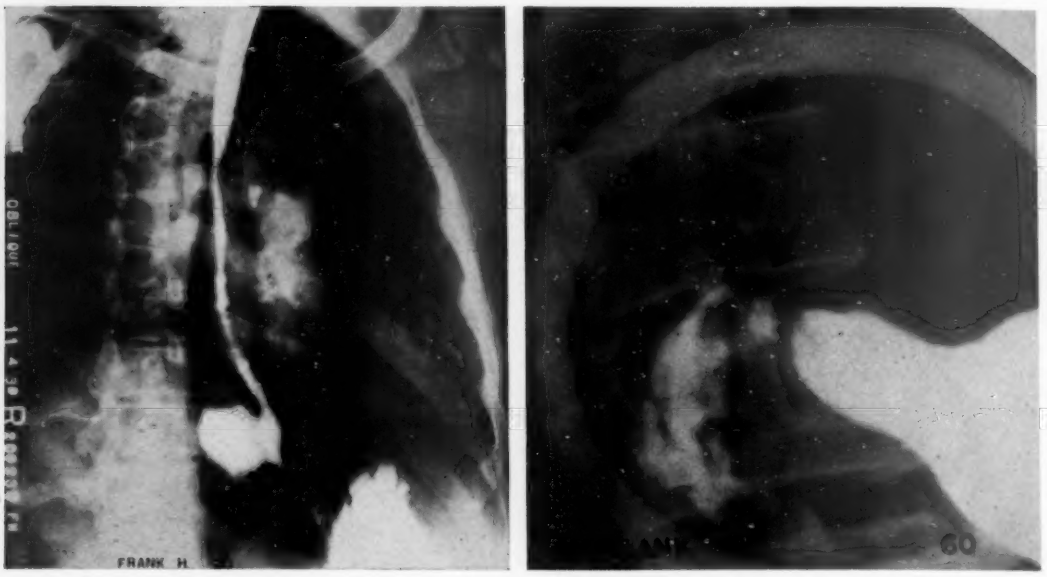

FIG. 3. Case IX. Diverticulum of lower esophagus associated with pyloric ulcer.

Roentgen Findings. Hiatus hernia with ulcer at hiatus.

CASE III. M. B., female, aged seventy-three. Incidental finding in partial intestinal obstruction due to adenocarcinoma of splenic flexure. Asymptomatic following resection of carcinoma. Re-examination shows persistence of hernia; no ulcer.

FIG. 4. Case XI. Gastric diverticulum associated with duodenal ulcer.

Roentgen Findings. Hiatus hernia with ulcer near the cardia.

CASE IV. J. S., male, aged fifty-one "Gas" and "indigestion," consisting in epigastric pain after eating. Duration five years. Some difficulty in swallowing for two years. Loss of 10 lb. in weight in last two months. Operative reduction of hernia with symptomatic and anatomic cure.

Roentgen Findings. Para-esophageal diaphragmatic hernia with ulcer at hiatus.

CASE V. J. Q., male, aged fifty-three. Increasing difficulty in swallowing solid food for five to six years. No pain or bleeding.

Roentgen Findings. Short esophagus with ulcer at cardia (above hiatus).

CASE VI. C. W., male, aged sixty-five. Inability to swallow solid foods for one year. Ulcer history for eighteen years with roentgenological confirmation. Symptoms during this time of epigastric, right upper quadrant and right lower chest pain coming on at night, relieved by sitting up. Occasional relief by alkalies. Loss of 30 lb. in weight in last three months.

Roentgen Findings. Short esophagus with ulcer at cardia (above hiatus); associated ulcer at pylorus (Fig. 2).

CASE VII. J. P., male, aged seventy-one. Pain in epigastrium during the past year; occasional vomiting; no weight loss.

Roentgen Findings. Hiatus hernia associated with prepyloric gastric ulcer.

Case viii. I. S., male, aged sixty-two. Pain both sides of abdomen, relieved by eating. No weight loss.

Roentgen Findings. Hiatus hernia associated with pyloric ulcer.

Case ix. F. H., male, aged sixty. Severe hematemesis, necessitating hospitalization. Attacks of hematemesis and melena for twenty-five years. Difficulty in swallowing "always." Inability to drink fluids quickly. Palpitation after meals, relieved by lying on abdomen; duration three years.

Roentgen Findings. Diverticulum of lower esophagus associated with healed duodenal ulcer (Fig. 3).

Case x. N. L., male, aged sixty-one. Sporadic difficulty in swallowing for one year. Excessive belching and severe upper abdominal pain appearing at irregular intervals for last two months. Loss of 5 lb. in weight since onset.

Roentgen Findings. Diverticulum of lower esophagus associated with healed duodenal ulcer.

Case xi. E. B., male, aged forty-two. Sharp pain in epigastrium after eating, at intervals for four months, relieved by powders and milk. Frequent vomiting. Loss of 15 lb. in weight in five weeks.

Roentgen Findings. Gastric diverticulum associated with duodenal ulcer (Fig. 4).

Case xii. E. M., female, aged twenty-five. Long standing "cardiospasm" with resultant mega-esophagus. Initial symptom hiccoughing after meals started ten years ago and persisted for seven months. Then difficulty in swallowing appeared. Lower esophagus dilated with relief for three months only. Phrenic crushing on left side six months with marked symptomatic relief and gain in weight. Recently recurrence of difficulty in swallowing accompanied by pain in epigastrium. Roentgen examination at this time showed ulcer at or near cardia which had not been present at previous examinations. All symptoms relieved by second phrenic crushing.

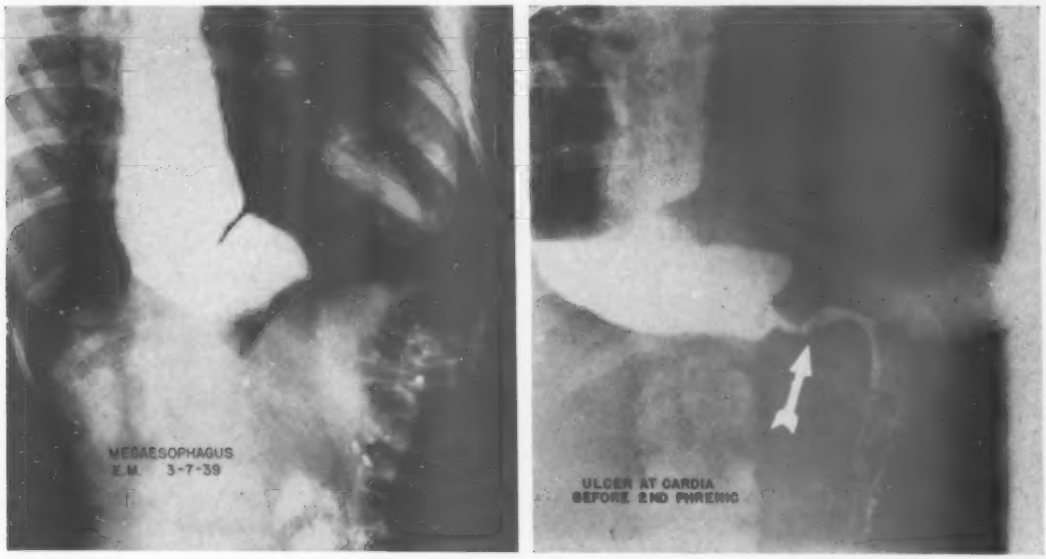

Fig. 5. Case xii. Mega-esophagus associated with ulcer at cardia. (Courtesy Dr. O. C. Pickhardt.)

Roentgen Findings. Mega-esophagus associated with ulcer at cardia (Fig. 5).

Case xiii. W. K., male, aged sixty-four. Ulcer symptoms for three weeks following long history of difficulty in swallowing and regurgitation of food at night.

Roentgen Findings. "Cardiospasm," multiple diverticula of lower esophagus, associated with prepyloric gastric ulcer (Fig. 6).

CONCLUSIONS

The association of ulceration in either the stomach or duodenum with benign lesions at or near the diaphragm is not uncommon and unquestionably accounts for some of the symptomatology manifested by these patients.

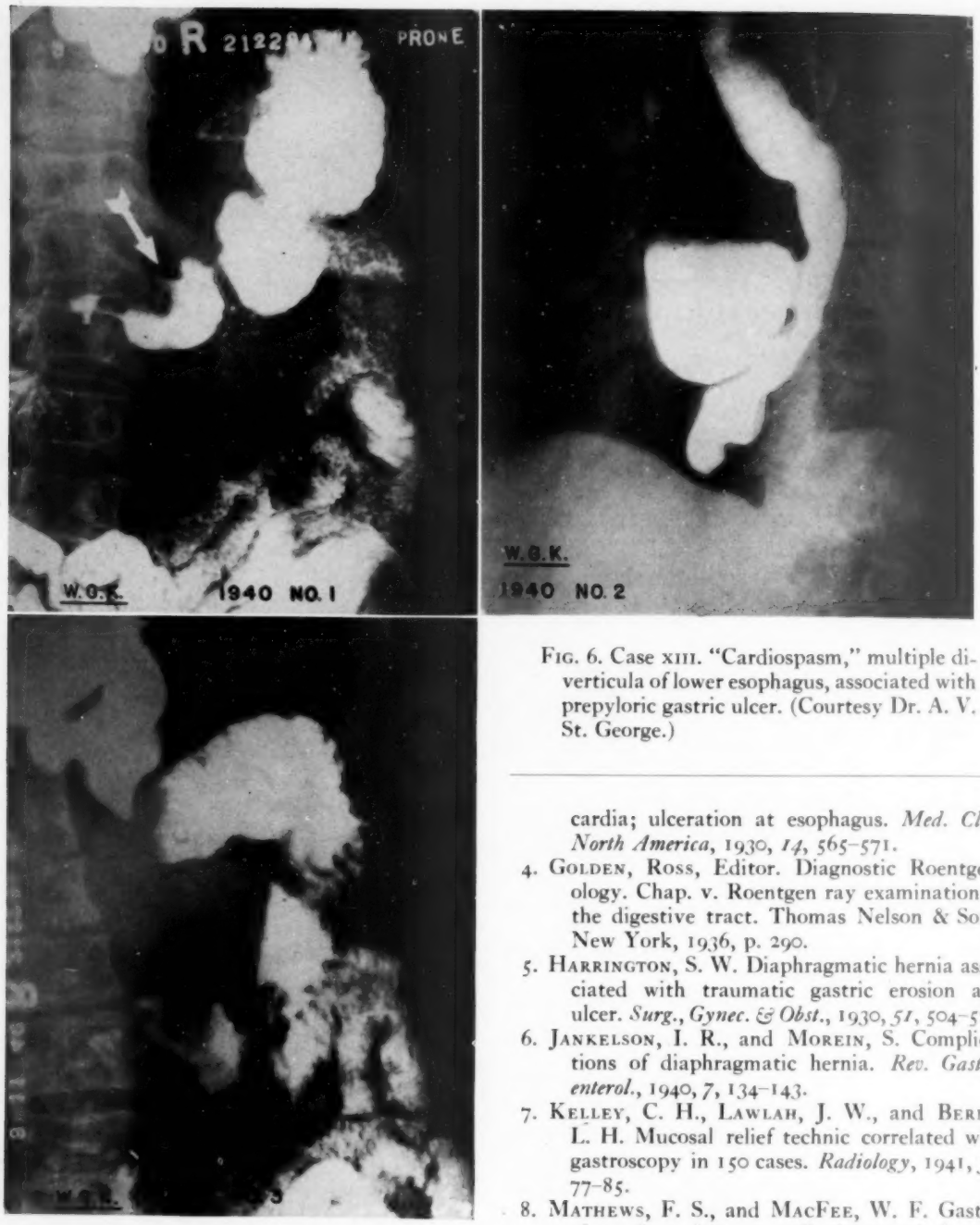

Fig. 6. Case xiii. "Cardiospasm," multiple diverticula of lower esophagus, associated with prepyloric gastric ulcer. (Courtesy Dr. A. V. St. George.)

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Vol. 48, No. 2

ADENOCARCINOMA OF THE ILEUM

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TUMORS of the small intestine have been more frequently reported during the last decade and are not considered as rare as formerly. Cutler and Buschke[4] state in their monograph on cancer that carcinoma of the small intestine occurs in about 3 per cent of the carcinomas of the intestines. Ewing[7] estimates that they occur in 3 per cent of the neoplasms of the entire gastrointestinal tract.

Eusterman, Berkman and Swan[6] state that a review of the literature shows that the duodenum is usually the site of a small intestinal tumor, disagreeing with the findings of the Mayo Clinic where in 39 cases, 15 were in the jejunum, 9 in the ileum and 15 in the duodenum. Raiford[17] described 7 in the jejunum, 16 in the ileum and 8 in the duodenum, found in 16,500 autopsies. Medinger[13] found 12 in the jejunum, 7 in the ileum and 3 in the duodenum. Nickerson and Williams,[14] however, in 343 tumors of the small intestine, discovered in 11,206 autopsies, found 8 in the duodenum, 2 in the jejunum and none in the ileum. Goldberg[8] reported 194 small intestinal tumors in 23,426 patients seen, of which 3 were in the duodenum, 6 in the jejunum and 1 in the ileum. Mayo[12] in a series of 108 cases in the small intestine, gave as the known sites, 29 in the duodenum, 40 in the jejunum and 27 in the ileum. Ullman and Abeshouse[20] think that they appear most commonly in the ileum, with the jejunum ranking second. Stein[19] judges from a study of the literature that sarcoma is more frequently found in the ileum than in the duodenum or jejunum but the reverse seems true of carcinoma. There is therefore no general agreement as to the most common site in the small intestine where these neoplasms occur.

As to the type of neoplasms found, the majority of writers agree that carcinoma is most common. Nickerson and Williams[14] reported 8 carcinomas and 2 sarcomas. Doub and Jones[5] state that adenomas and fibromas are the most common types of benign tumors in the jejuno-ileal segment, with the ileum the most common site, but they report 2 sarcomas and 4 carcinomas in the jejunum and 2 sarcomas and 1 carcinoma in the ileum. Nickerson and Williams[14] in their series found 10 adenosarcomas, 1 carcinoma simplex, 5 malignant adenomas and 6 leiomyosarcomas. Ragins and Shively,[16] reporting 10 tumors of the small intestine found in 11,000 autopsies at the Cook County Hospital, describe 2 adenocarcinomas, 1 leiomyosarcoma and 1 lymphosarcoma in the duodenum, 7 adenocarcinomas out of 8 tumors of the jejunum and 3 in the ileum, of which 1 was an adenocarcinoma. Cohn, Landy and Richter[3] give a summary gathered from the literature of tumors of the small intestine, quoting 15 adenomas reported by Raiford, 10 of them in the ileum; fibroma they found to be rare; leiomyoma quite frequent; lipoma and hemangioma rare and carcinoid frequent. Of the malignant tumors, they say that carcinomas are the most frequent of those found in the small intestine and that metastases are found in one-third of the cases at time of operation. Joyce[11] has found that the ileum has the fewest number of carcinomas and greatest number of tumors of the lymphoblastoma group.

Despite their disagreement as to the most favorable site of tumors of the intestinal tract, every writer agrees that the invariable symptoms are great loss of weight within a short time, recurrent attacks of intestinal obstruction and vomiting. Clark[2] says the vomiting may be greenish in color or, in well developed cases, brownish with fecal odor. A few writers have found a slight anemia present in these cases.

Diagnosis is not easy, according to all writers. Roentgen examination may be helpful. Pack and Livingston[15] find no constriction or stenosis of the segment but a

tremendous dilatation of the intestine above the obstruction. Cohn, Landy and Richter[3] give dilatation, filling defects, indentations due to constriction or evidences of acute or chronic obstruction, as roentgen findings in these cases. Brooksher[1] gives as roentgenological evidence, dilatation with retention of opaque meal, filling defect and a point of narrowing of the lumen of the small intestine. He further states, as do many writers, that diagnosis is seldom made by roentgen examination and cases are found during exploratory laparotomy or at autopsy.

Rankin and Mayo[18] have suggested that alkalinity and fluidity of the contents of the small intestine and the absence of abrupt bends may be reasons for the infrequency of neoplasms in the small intestine, a suggestion that has been widely quoted. Harries and Harrison[9] ask, however, if it is not more likely a question of cell nutrition and absorption rather than irritation.

Prognosis is not usually good. Clark[2] states that the highest mortality is found when the lesion is in the ileum, although a few cures have been recorded. Brooksher[1] found from a study of the literature that mortality from primary carcinoma of the jejunum varies from 30 to 100 per cent. Hunt and Kaneb[10] reported recently a postoperative survival in carcinoma of the jejunum of eleven years and two months in one case, another of two years and four months, while a third case, that of an aged person, died from metastases. Rankin and Mayo[18] state that metastasis usually accompanies cancer of the small bowel and takes place early.

As Hunt and Kaneb have said, we are reporting a case of adenocarcinoma of the ileum, "because we believe that by focusing the attention of clinicians on the condition, improved results may follow its more seasonable recognition." We present a case with typical symptoms—loss of weight, partial obstruction, vomiting, a slight anemia and roentgen evidence. Illustrations showing roentgen findings are included.

REPORT OF CASE

Mrs. L. D., aged forty-nine, married but separated from her husband, employed in an institution, gave a history of poor appetite, attended with a weight loss of 60 pounds within a few months, and frequent vomiting of coffee-colored fluid. She described her stools as being flat, ribbon-formed and in small pieces.

Physical examination was negative except for slight distention of the abdomen and a yellowish tinge of the skin. The patient stated there was no record of tuberculosis, diabetes or cancer in the family. Her mother died at seventy-five of dropsy and her father at twenty-one of pneumonia.

Laboratory findings were erythrocytes 4,460,000; hemoglobin, 90 per cent; leukocytes, 11,350, with polymorphonuclears, 67 per cent. lymphocytes, 30 per cent; monocytes, 1 per cent; eosinophiles, 2 per cent.

Roentgen examination showed nothing unusual in the esophagus and stomach proper; the bulb or cap of the duodenum was greatly distended, as were the second and third portions; the jejunum and ileum were greatly distended. There was some gastric retention after five hours. The trouble seemed localized in the proximal portion of the ileum, fairly well in the pelvis and just to the right of the midline. Findings suggested constriction at this point causing the partial obstruction noted (Fig. 1, 2 and 3).

Operation was done under spinocain. A right midline incision was made, the peritoneum opened and the abdomen explored. Miliary tubercles were found present in the peritoneum. A tumor the size of a large plum was located in the ileum, causing partial obstruction. The proximal ileum was dilated and the distal ileum collapsed. The ileum was mobilized, packed off with hot towels and the tumor resected with cautery. Anastomosis, side by side, was done and 10 gm. of sulfanilamide left in the peritoneal cavity. The incision was closed by layer suture without drainage.

Gross examination of a segment of the small intestine showed gray serosal surface, spotted with translucent nodules about 1 mm. in diameter, having the appearance of typical tubercles. The wall of the bowel showed the mucosa to be nodular without the usual plicae. The submucosa was thick and gray, the subserosa opaque and thick. Much gray tubercular tissue extended into the thickened mysentery.

Microscopic examination showed invasion

of the ileum by large abnormal epithelial cells, not by tubercles. The cells appeared to invade from the serosal layer and in a few places passed through the mucularis but did not involve the epithelium of the ileum. They seemed to lie frequently in the lymphatics with a clear space about them. They lay singly in small clusters and covered small connective tissue papillae or bordered in a single layer segment of the invaded muscle coat. In the mesentery there was much acute and chronic inflammation and formation of small abscesses, as well as tumor in-

Fig. 1

filtration. Diagnosis was primary carcinoma in the ileum with ileal obstruction.

The patient was discharged on the twentieth day, after a rather stormy convalescence. Intravenous glucose solution was given the first three days and saline solution for two more days, to stimulate the patient postoperatively. On the first postoperative day, the transfusion was stopped because of a chill that developed and lasted for fifteen minutes. The temperature on the first day after operation was 102.8° F., pulse 112; on the following day, 102.4° F., and pulse 120; and on the next day the temperature rose to 104.2° F. but dropped to normal the following day without further rise. A blood transfusion was given on the third day after

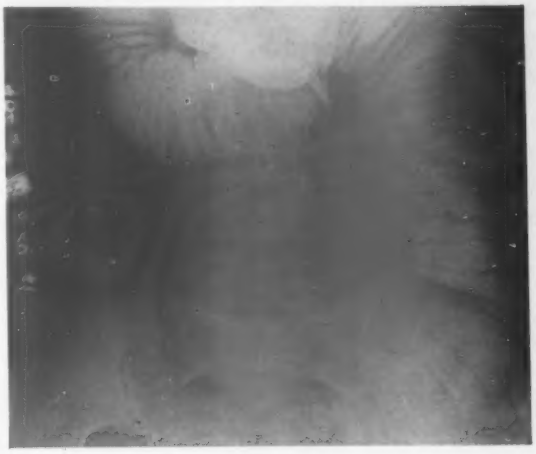

Fig. 2

operation but was stopped after 125 cc. was taken, because of a chill lasting thirty-five minutes. The patient complained continuously from flatus, sometimes relieved by vomiting. On the sixteenth day paregoric was given for gripping pains but was immediately vomited and the pains were controlled by prostinin. The abdomen remained soft throughout, with no tenderness. The patient's condition on discharge

Fig. 3

was improved. At the present time, three and a half months after operation, the woman is alive and well with practically no symptoms.

SUMMARY

A review of the recent literature indicates that carcinoma of the ileum and other segments of the small intestine, although a rare condition, is now being more frequently recognized before autopsy.

A report is given of such a case, with the symptoms now recognized as invariable, that is, loss of weight, partial obstruction with vomiting and roentgen findings which indicated such obstruction.

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MESENTERIC CYSTS

THEIR ROENTGEN DIAGNOSIS*

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CYST of the mesentery is one of the rarer pathological conditions of surgical importance. The first recorded case was described in 1507 by Benevieni,[36] since which time several hundred have been added to the medical literature.

The incidence has been estimated at 1 in 100,000,[15] and 1 in 93,000[31] hospital admissions. They are diagnosed with great difficulty, produce grave surgical complications and have caused a number of deaths.

It is the purpose of this paper to review briefly the symptoms, diagnosis, classification, and pathology of this condition. Particular emphasis will be placed upon roentgenological contributions to the diagnosis.

In many cases the cysts remain so small as to be symptomless. Symptoms may occur, however, as the result of mass, traction, compression or torsion (Luker[19]) with resulting compromise of the intestinal blood supply. Chronic or acute intestinal obstruction may develop.[4] This was present in about 60 per cent of the recorded cases. Other serious but less common complications are hemorrhage into[36] or rupture of a cyst (Eliason and North[7]) (Dutton[6]). Malignant changes within cysts have been described.[20,25]

"Mesenteric cyst" is merely a descriptive term and includes any cystic structure which lies between the leaves of the mesentery or beneath the serosa of the intestine. It excludes the retroperitoneal structures.[5] Except for the feature of position, these cysts have but little in common. Etiology, embryonic genesis, cellular structure and contents have been shown to vary greatly.

Many analytical studies of these lesions have been made and classification schemes have been progressively improved and simplified by Dowd,[5] Niosi,[23] Gould,[10] and Higgins and Lloyd.[13] Inasmuch as there is no universally accepted classification, that of Peterson[26] will be given here:

1. *Embryonic*
   - A. Arising from embryonic remnants and sequestrated tissue. These may be serous, chylous, sanguineous or dermoid.
   - B. Cysts of intestinal origin arising as a result of
     - (1) sequestration from the bowel
     - (2) from diverticula of the concave side of the bowel, thus reaching an intramesenteric position.
   - C. Cysts arising from urogenital organs, germinal epithelium, ovary, wolffian body or müllerian duct.

2. *Pseudocysts*
   - A. Infective origin
     - (1) Hydatid cysts
     - (2) Degenerated tuberculous disease.
   - B. Cystic malignant disease.

PATHOLOGY

Mesenteric cysts, single or multiple, may be found almost anywhere along the course of the intestine, somewhat more commonly in the mesocolon.[8] Warfield,[37] who reviewed 129 cases from the literature, found only 14 in the jejunal mesentery. They have been reported in fetuses,[33] infants,[4,22,27] and the aged.[25] They are somewhat more common in females. The size is extremely variable, ranging from pea-sized, bleb-like structures to cysts stretching from xiphoid to symphysis. The incidence of surgical complications is very high.[17,19,37]

Probably the simplest form is that which contains chylous, lymphatic or serous contents. This type usually has a dense fibrous

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wall in which there are small lymphocytes and lymph follicles. The lining cells resemble endothelium similar to that lining lymphatic vessels. Lymphatic channels are occasionally seen. Bundles of smooth muscle may be present. There may be fatty material or cholesterol crystals about which giant multinucleated cells cluster. The cyst contents are liquid, semifluid or greasy, depending upon the amount of fat or solid material present and the amount of inspissation which has taken place. It has been suggested that the so-called "hemorrhagic" cysts are lymphatic or chylous cysts into which some blood has escaped.

This type of cyst has been more completely studied than the others. The following table taken from Slocum[34] compares the fluids analyzed by several workers. Figures are given for chyle, chylous effusions and chylous cysts. Messer,[21] commenting on the high total solids, ash and calcium figures for the first case, suggests that calcification was taking place.

Table I

	Chylous Cysts			Chylous Effusions	Chyle	
Name of investigator	Slocum	Zdarek	Schumm	Buchtala	Panzer	Sollman
Specific gravity	1.0120		0.988	1.0176		
Total solids—per cent	12.45	10.58	39.7	8.66	9.71	7.10
Protein—per cent	3.84	7.19	1.95	4.69	2.16	1.85
Ash—per cent	1.85	0.84	0.92	0.95	0.81	0.6
Calcium—per cent	0.468		0.15	0.09		

Enteric cysts or enterocystomas are somewhat more readily identified. The wall is fibrous and is lined by secreting epithelial cells resembling those of the gastrointestinal tract. Not infrequently these cells are ciliated like the lining cells of the embryonic gastrointestinal tract. The wall may contain smooth muscle and lymphoid tissue. The cyst contents are colorless, yellow or brownish, and mucinous. This type is said to be most common in the ileum near the omphalomesenteric duct.[8]

Dermoid cysts similar to those of the ovary may be found anywhere along the gastrointestinal tract or in the mesentery. They are lined with squamous epithelium and may contain hair or sebaceous material. All degrees of differentiation may be encountered and in the more complex cysts (teratomas) teeth, cartilage or bone may be found.

Cysts of supposedly nephrogenic origin are usually found in adult women (Ewing[8]). The fibrous wall of these structures is lined by high cylindrical or cuboidal epithelium. The contents are brown and serous, usually admixed with pseudomucin. These are said to arise from aberrant wolffian explants and may contain cells resembling kidney or adrenal cortex.

The other cystic structures included in Peterson's classification show the familiar infectious, parasitic or neoplastic elements which are to be found in these diseases located elsewhere in the body and they will not be described here.

It would appear simple to classify these cysts by histopathological study[16,37] but, unfortunately, due to the effects of high intracystic pressure, hemorrhage, necrosis or infection, the lining cells are often modified or absent. In such cases, even the pathologist finds it impossible to classify a specimen.

CLINICAL

From the point of view of the surgeon or roentgenologist, accurate nomenclature and genesis are secondary in importance to the recognition of the nature of the disease, estimation of the amount of bowel compres-

sion and exact localization of the cyst. The difficulty of diagnosis was pointed out by Swartley[36] in 1927. He stated that a correct preoperative or antemortem diagnosis had never been recorded. The diagnosis, however, has been correctly made in a few instances (Warfield[37]), but this is rare indeed. Obviously, the clinical diagnosis is rendered difficult or impossible because the symptoms are nonspecific; the objective findings in many emergency cases are obscured by the complications (distention, obstruction, peritonitis, etc.), and laboratory findings are not helpful.

ROENTGENOLOGY

Little use has been made of roentgenologic methods in the diagnosis of this condition. In most of the reported cases, no roentgenograms were taken. In certain instances the patients were obviously in such need of immediate surgical intervention (because of obstruction or perforation) that accurate diagnosis by roentgen or other means became secondary in importance and immediate operation was done. In the few cases studied by roentgen methods, the examinations were inadequate in their scope, did not include roentgenoscopic palpation, and contributed little to establish the diagnosis. The cases of Parker[24] and Ball[1] are exceptions to this generalization. Joyce, Howard and Fitzgibbon[14] showed indentation of the colon by barium enema.

A single abdominal film is seldom of great diagnostic assistance, yet Ball (1917) said the rays were "held back" by the cyst. Parker's case also showed a shadow. In the 3 cases reported below, shadows were cast by each cyst and all three were identified on supine abdominal films. Important information concerning the location of the mass was obtained by roentgenoscopic palpation after the administration of barium by mouth and/or by rectum. Two of the cases showed indentation of nearby viscera. In Case II intravenous pyelograms were made to supplement the barium studied. Our earliest case was studied by pneumoperitoneum (1920).

To be seen on a film an intra-abdominal cyst must be different in density from the surrounding tissues. Ball's cyst was apparently quite dense. Others have described cysts having the same density as the kidney. Dermoids and teratomas, of course, often contain bone, cartilage or teeth, and hydatid cysts calcify readily in all locations. As stated above, one of our cases contained calcium within its capsule. Cysts filled with sebaceous material may be radiolucent or mottled (Robbins and White[30]).

REPORT OF CASES

Because of the rarity of these lesions, the grave surgical consequences resulting from them, and the extreme difficulty of diagnosis, 3 cases are herein reported. These were studied in the Vanderbilt Clinic and in the Presbyterian Hospital. They are reported together because in all three the cyst resided in the mesentery of the proximal small intestine, preoperative diagnosis was correctly established, and surgical removal was successful. It will be noted that roentgenological methods played a prominent rôle in the establishment of the diagnosis in each case.

Each of these patients had signs and symptoms referable to the cysts, but none had obstruction or were forced into immediate surgery for other reasons. In no case was the lesion too large to be manipulated or to permit study of its relation to adjacent structures.

Case I. S.K. (Unit No. 47836.) A boy, aged three, was brought to the hospital October 4, 1920, because of enlargement of the abdomen and pain in the left suprapubic region for three months. The abdominal enlargement was first noted eleven months previously when his abdomen was slightly painful. The pain and mass disappeared. Three months before admission they reappeared, accompanied by fever, weight loss and vomiting. His bowels moved normally. For two weeks previous to admission the child walked with a limp and said that running made the pain worse.

Physical Examination. Temperature, 99°F.; pulse, 110; respiration, 20. A mass 6 by 8 cm. was felt below and to the left of the umbilicus.

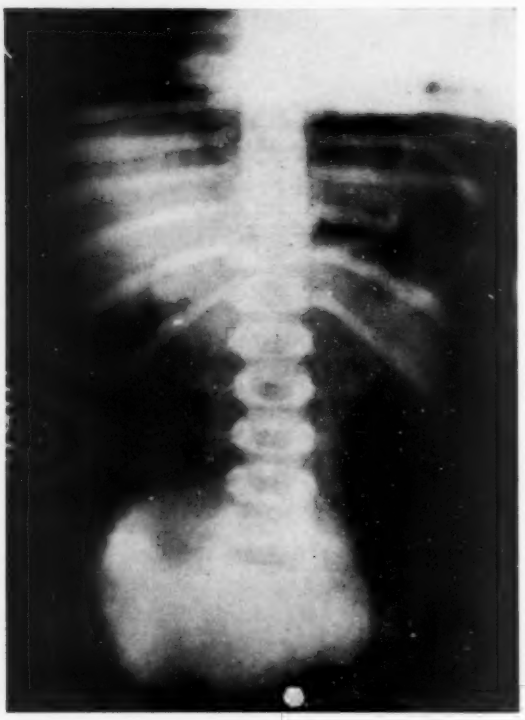

Fig. 1. Case 1. Dense mesenteric cyst in a child. A supine film of the abdomen showing the large ovoid shadow of increased density in the suprapubic region.

This was slightly tender, firm and freely movable, especially toward the left and upward.

Roentgen Examination. A roentgenogram of the abdomen taken October 25, 1920, showed the presence of a large ovoid shadow of increased density lying in the right lower quadrant (Fig. 1). Following intraperitoneal oxygen injection, fluoroscopic palpation was done and films were taken of the abdomen with the patient in lateral decubitus positions. The large mass was well outlined (Fig. 2). No barium was administered.

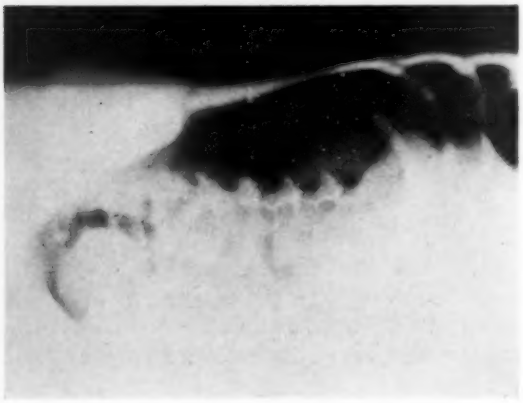

Fig. 2. Case 1. Pneumoperitoneum with mesenteric cyst. After pneumoperitoneum, a film in lateral decubitus position, with the right side up and the rays passing horizontally, shows the large tumor in the right lower quadrant. The patient was palpated roentgenoscopically after the oxygen insufflation.

Fig. 3. Case 1. Mesenteric cyst. Surgical specimen shelled from between the leaves of the small intestinal mesentery at operation.

The preoperative diagnosis was fibroma or cyst of mesentery or omentum.

Operation, October 25, 1920, disclosed a thick-walled cyst 2 inches below the superior mesenteric artery between the leaves of the proximal small intestinal mesentery. This was shelled out intact. Multiple enlarged lymph nodes were found in the mesentery. One of these was removed. Recovery was immediate and uneventful.

Surgical Pathology, October 26, 1920. Specimen (1) was a cyst measuring 8 by 6 by 5 cm. Its surface was gray (Fig. 3). It contained 180

cc. of thick, creamy fluid. The cyst wall was 2 to 3 mm. in thickness and had a smooth inner surface.

Microscopically, the cyst wall was hyalinized connective tissue, infiltrated at intervals by small blood vessels and round cells. Diagnosis: cyst of mesentery (lymphatic).

Specimen (2) was a lymph node. This on section showed hyperplasia. Diagnosis: mesenteric lymphadenitis.

Seven years later the patient was well.

Case II. R.A. (Unit No. 604202). An Italian seamstress, aged twenty-nine, came to the clinic in March, 1940, complaining of abdominal pain and constipation for three weeks. At the onset she was awakened at night by severe left-sided abdominal pain. She became nauseated, vomited and fainted. Shortly after this the pain became less severe. She noted constipation from that time on and had a "nagging" pain in the left upper abdomen. In the five days previous to admission, the pain increased in severity and became colicky in nature.

Fig. 5. Case II. Chylous mesenteric cyst. Surgical specimen. Cyst removed from jejunal mesentery.

Fig. 4. Case II. Small mesenteric cyst of kidney density. Supine abdominal film made fifteen minutes after the intravenous injection of urinary tract dye. Arrows delineate the mesial and inferior borders of the cyst which indents and displaces the gas-filled colon. The genitourinary tract was normal except for the bifid pelves. The cecum and ascending colon contain barium. The cyst was shown to be in the mesentery by palpation under roentgenoscopy following barium ingestion and barium enema.

As a child the patient had malaria in Italy. Five years before admission she was told she had inflammation of the kidney. Her brother was operated upon in this hospital for an echinococcus cyst of the liver.

Physical Examination. Blood pressure, 110/70; temperature, 100° F.; pulse, 92; respiration, 20. On physical examination a tender, firm, smooth, movable mass, 6 cm. in diameter, was found in the left upper quadrant of the abdomen. It could be balloted below the usual position of the left kidney.

Laboratory tests, including *Taenia serrata* skin tests, were negative.

Roentgen examination of the gastrointestinal tract showed the stomach to be indented from behind and displaced forward by a mass. The duodenum and jejunum appeared normal. When the patient was supine (Fig. 4), the mass was in the region of the ligament of Treitz, but when she stood erect it was palpated several centimeters below and to the left of the stomach. When barium was introduced by rectum, the descending colon (supine position) was found to be displaced and indented from behind forward by the smooth mass. The mass and the colon could be moved independently of

Fig. 6. Case II. Chylous mesenteric cyst. Inner surfaces of the cyst after sectioning and removal of the lard-like contents.

each other. This was interpreted as suggesting a cyst of the mesentery.

At operation a baseball-sized cyst was found between the leaves of the jejunal mesentery about half way between the root and the bowel. The cyst was shelled out and recovery was uneventful.

Surgical Pathology. The specimen was a kidney-shaped cystic mass 7 by 6.5 by 5.5 cm., having the consistency of a rubber sponge (Fig. 5). On opening, the cyst proved to contain 105 cc. of thick, creamy, yellow fluid. This had a specific gravity less than 1 and an odor of ether. The cyst wall was 1 to 3 mm. thick, and lined with a smooth, gray, glistening surface (Fig. 6).

Microscopically, there was no definite cellular lining of the cyst. The wall contained parallel strands of fibrous connective tissue which was infiltrated by lymphocytes and polymorphonuclear leukocytes. In scattered areas of the lining there were groups of large foam cells with small nuclei. Within the wall itself there were many small lymph follicles. Vacuolated areas and clefts, the shape of cholesterol crystals, were found surrounded by multinucleated giant cells. Diagnosis: lymphatic (chylous) cyst of the mesentery.

Special Studies. Some of the thick cyst contents were stained with Scharlach R. Many fat droplets were found.

The lard-like material was sent for chemical analysis. It was almost completely soluble in ether. The specific gravity was less than 1.

Total solids	=34.7%
Neutral fat	=73.0% of total solids
Protein	=10.0% of total solids
Cholesterol	= 4.0% of total solids

The remaining 13 per cent of total solids includes many more complex forms of lipoids, which will not be enumerated. This specimen contained the largest percentage of total solids and neutral fat ever recorded in such a cyst. It is of interest that its shadow on the roentgenogram was similar in density to the kidney.

Case III. B.S. (Unit No. 617108). An unmarried female, aged fifty-three, telephone operator, came to the out-patient department on July 23, 1940, complaining of pain in the abdomen and weight loss. During the previous year she noticed a tired feeling together with mild attacks of indigestion and eructations. For three months she had "burning in the stomach," made worse by starchy foods and relieved

by rhubarb and soda. Her appetite became poor, she experienced a persistent "gnawing in the stomach" and lost 15 pounds.

Physical examination disclosed a thin, pale woman who had apparently lost weight. Blood pressure, 140/75; temperature, 100° F.; pulse, 104; respiration, 22. The abdomen was soft and a mass 3 cm. in diameter was felt to the left of the umbilicus. This was hard, slightly tender and had several centimeters mobility in all directions. The liver extended three fingers below the costal margin. At this time the clinical impression was a neoplasm of the gastrointestinal tract with metastases to the liver. She was referred for a roentgen examination of the gastrointestinal tract.

Roentgen Examination. The esophagus, stomach, and duodenum were not abnormal. A ring shadow of calcium density was seen in the left lower abdomen. This corresponded to the mass clinically described. It could be pushed 2 to 4 cm. by palpation, and by changing the position of the patient it was found that the stomach moved more freely than the ring shadow (Fig. 7 and 8). With the patient supine, the spherical mass was behind the stomach, from which position it indented the posterior wall of the pars media. When the table was tilted, placing the patient in the head down position, the sphere appeared below the greater curvature and could be grasped. In this position it could be seen that the third portion of the duodenum lay adjacent to it and the proximal loops of the jejunum coiled around it, affording evidence of its extraluminal situation. The spherical mass appeared to be very close to the ligament of Treitz (Fig. 9). This was interpreted as a cyst in the jejunal mesentery. Several gallstones were also demonstrated.

Fig. 7. Case III. Calcified mesenteric cyst. This small cyst (arrows) was recognized during a gastrointestinal series. The patient is erect and the stomach falls beneath and anterior to the cyst which is readily palpable.

Fig. 8. Case III. Calcified mesenteric cyst. With the patient supine, the spherical calcified shadow is seen through the stomach which is sharply indented from behind.

Laboratory Tests. Blood count, stool examinations, urine analyses, and *Taenia serrata* skin tests were all negative. The sedimentation rate varied between 22 and 30 mm. in the first hour.

At operation a globular, calcified mass was found between the leaves of the jejunal mesentery. It was readily shelled out. The gallblad-

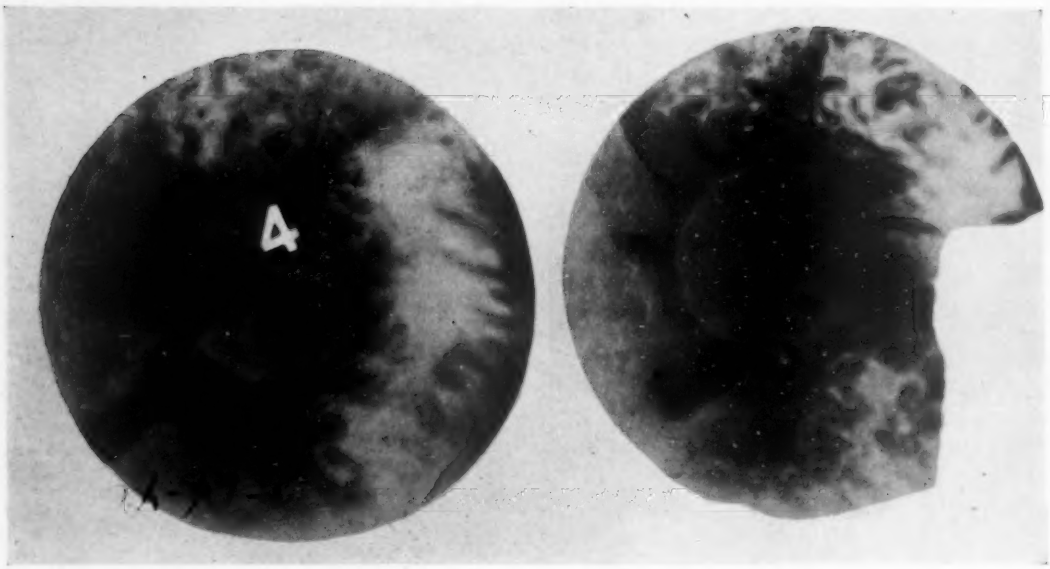

Fig. 9. Case III. Calcified mesenteric cyst. Films of the proximal jejunum (at the ligament of Treitz) made with pressure technique. The bowel lumen is not compromised. The cyst is extraluminal.

der was enlarged and contained several stones, but, because the patient showed signs of shock, a cholecystectomy was not done. Her recovery was uneventful and she was discharged on the fourteenth postoperative day.

Surgical Pathology. The specimen was a roughly spherical, firm mass 3.6 cm. in diameter (Fig. 10). Its surface was pinkish gray, smooth and glistening. The cyst was filled with yellowish gray, soft, granular material. The wall was 4 mm. thick and contained calcium.

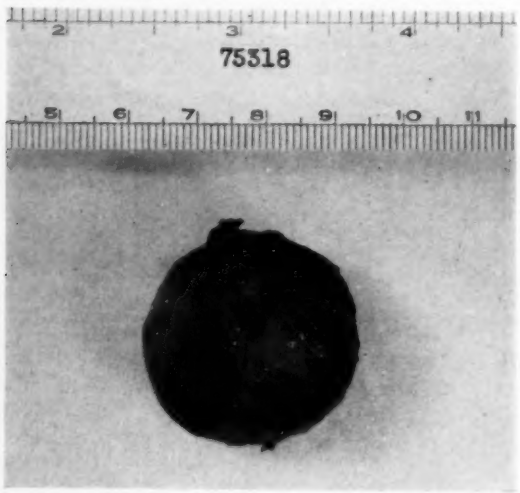

Fig. 10. Case III. Calcified mesenteric cyst. Surgical specimen before sectioning. The thin fibrous wall contained many plaques of calcium.

Microscopically, the cyst wall was composed of dense fibrous tissue in which there were several foci of lymphocytes and plasma cells. There were calcium depositions in the fibrous tissue. No definite cellular lining was found. Diagnosis: cyst of mesentery (lymphatic), calcified.

Follow-up January 27, 1941. The patient felt perfectly well without symptoms referable to the abdomen or biliary tract.

Discussion

Case I. This is of interest because the cyst was dense enough to cast a readily detectable shadow on a flat roentgenogram of the abdomen. It occurred in a child of three and was clearly demonstrated by pneumoperitoneum and roentgenoscopic palpation.

Case II. This cyst cast a roentgen shadow the same approximate density as that of the kidney. By means of barium enema and barium by mouth, it was demonstrated to be posterior to the descending colon, behind the greater curvature of the stomach and was less freely movable than the jejunal loops in whose mesentery it lay. It contained 34.7 per cent total solids, of which 73 per cent was neutral fat. These figures exceed any others thus far reported.

Case III. This small cyst was recognized first by roentgen examination. Its calcified wall was seen during a routine gastrointestinal examination for suspected cancer of the stomach. It was behind, above and below the stomach (depending upon the position of the patient), and just below the angle of Treitz. It was only slightly movable because it lay close to the root of the jejunal mesentery.

In all three of these cases there was a palpable mass. In only Case II did this feel cystic. All three were visualized on flat abdominal roentgenograms and each was identified and located in the mesentery before operation. Because of its calcified shell, Case III could be accurately localized to the root of the jejunal mesentery. All three diagnoses were verified at operation.

The calcification present in Case III is interesting and fortuitous, but not surprising. The cyst wall is usually dense, poorly vascularized, fibrous or collagenous in nature and contains devitalized cells. Cystic growths of other kinds are prone to calcify,[2] and one might expect a cyst of this kind which is filled with organic calcium containing material to offer suitable conditions for the deposition of calcium salts.

In a number of cysts in the literature, calcium was found upon sectioning the wall,[36] but its presence was not demonstrated by roentgenography and therefore did not contribute toward establishing a correct preoperative diagnosis. It is probable that a search by the roentgen ray would reveal more calcium containing cyst walls and assist in the diagnosis.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis by clinical means has been discussed by Slocum[34] and will not be taken up here. He lists ovarian cyst, retroperitoneal tumor, pancreatic cyst and tumor, bowel tumor, pedunculated fibroid, movable kidneys, hydrops of the gallbladder, omental cyst, tuberculous abscess and splenic tumor.

The roentgenologic differentiation of the shadows on an abdominal film must be considered in two parts: (1) noncalcified cysts of the mesentery must be distinguished from cysts or tumors of the ovaries, omentum, pancreas, kidneys or other retroperitoneal structures; (2) calcified circular shadows raise the question of tuberculous abscess or nodes, splenic artery or vein calcification, degenerated fibroids, fibroma of mesentery, foreign body, hematoma, barium from previous perforation of the gastrointestinal tract, calcified gallbladder, parasitic infestation (echinococcus disease), pedunculated dermoid of ovary and solitary cyst of kidney. Abdominal pregnancy might give rise to a ring shadow of calcium density.[22]

The differential diagnosis can best be made by the barium meal or enema. The determination of the exact location of the mass by roentgenoscopic palpation is of prime importance in the differential diagnosis. It may be necessary to identify the kidneys by intravenous or retrograde pyelography. If the cyst is of sufficient size to be palpated, it will indent the barium-containing gastrointestinal tract, and the relative positions of each can be studied, as well as their relative mobilities. The most anterior and freely movable lesions are in the omentum, the less mobile masses indenting the gastrointestinal tract from behind are in the mesentery, while those lying far posteriorly and immobile are retroperitoneal.

Tumors of the mesentery, such as fibroma or lipoma, lymphangioma, hemangioma, and neurogenic tumors,[11,28,29,35] would be impossible to differentiate by roentgen means. These are, however, even less common. Fibromas frequently calcify.

CONCLUSIONS

Cysts of the mesentery comprise a heterogeneous group of lesions which are rarely diagnosed clinically. They are important because of the potential danger of obstruction, volvulus, infection, hemorrhage, rupture or malignant change. Etiology, genesis, and microscopic pathology are variable and classification is frequently difficult.

Roentgenological methods appear to offer an opportunity for more frequent di-

agnosis based on the visualization and localization of these lesions. The cyst may be seen because of increased or decreased density, opaque inclusions or calcification within the cyst wall. Further identification and orientation can best be achieved by roentgenoscopic palpation and study of the displacement or indentation phenomena to be found in adjacent barium filled viscera.

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THE PANCREAS SEEN THROUGH A GASTRIC ULCER

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THE patient was a Chinese male, aged forty-one, who had been suffering from periodic attacks of epigastric pain for the last five years. The pain usually started two hours after a meal and was relieved by bicarbonate of soda or by food and sometimes by belching. No heart burn; no vomiting; appetite good. He was admitted to the hospital on January 23, 1939, because of unusually severe epigastric pain, followed by hematemesis. There was considerable anemia but, apart from this, physical examination was negative. Free hydrochloric acid was absent.

Roentgen examination showed that the stomach consisted of three compartments

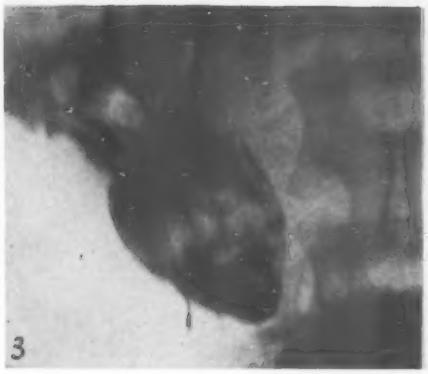

FIG. 1

FIG. 2

FIG. 3

FIG. 4

(Fig. 1 and 2), the first and the third of which had normal walls, whereas the second one extended beyond what should be the line of the lesser curvature and had irregular and rigid walls. This cavity was separated from the upper and lower parts of the stomach by two filling defects, and only towards the greater curvature mucosal folds were seen forming a narrow path of normal mucosa along which the barium passed from the higher compartment to the lower ones. It appeared, therefore, that there was a cavity extending outside of the stomach and surrounded by thick pathological tissue which had invaded the stomach wall around it. The relief picture (Fig. 3) showed several constant circular filling defects inside the cavity which were obviously due to nodules and for that reason a diagnosis of malignant ulcer was made.

The patient died of peritonitis a few weeks later. At autopsy (Dr. H. Lucke), a peptic ulcer the size of the palm of a hand was found involving the lesser curvature and the posterior wall of the stomach. The edges were callous and the nodular ground was formed by the pancreas, the stomach wall having been completely destroyed throughout the whole ulcer area.

Microscopic examination confirmed that this was a non-carcinomatous callous ulcer. Figure 4 represents a section through a nodule on the floor of the ulcer and shows only normal pancreas covered by a thin layer of necrotic tissue.

The nodular surface of the bare pancreas which had been visualized in the roentgenogram had been misinterpreted as being due to a growth.

VENEREAL LYMPHOGRANULOMATOUS RECTAL STRICTURE*

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IN ITS broadest sense, the term "rectal stricture" denotes a simple pathological lesion: the narrowing of the rectal lumen caused by a variety of conditions. The majority of these are of little importance. One type of rectal stenosis, however, has long been the subject of scientific interest,[25,37,64,72,77] although its character as a definite clinicopathological entity was firmly established only about a decade ago.

Formerly called venereal, inflammatory or benign, this form of rectal stricture is usually located from 4 to 8 cm. above the mucocutaneous line as an annular or tubular chronic infectious granulomatous mass. It occurs with preponderant frequency in women in the third and fourth decades and is notoriously resistant to treatment. It is often associated with chronic suppurative or fibrous hyperplastic changes in the perianal and external genital regions, has a history extending over a number of years and is known to have a poor prognosis.

Previously attributed to a number of pathogenic agents, in the latter years this disease has been proved to represent the anorectal localization of lymphogranuloma venereum, a venereal disease caused by a filterable virus. Virtually all the patients presenting this rectal lesion show a positive skin reaction[21,29,31,34,51,53,78,79] to the intradermally administered antigen of lymphogranuloma venereum (Frei test[18,26,27,36]). In many instances the presence of the specific virus has been demonstrated in the granulation tissue and its exudates by biological experiments.[7,33,49,52,58,60,62,63,70] Only rarely are rectal lesions encountered that closely resemble rectal lymphogranuloma venereum but are brought about by other agents (syphilis,[30] tuberculosis,[73,83] amebiasis,[39,82] actinomycosis,[81] and others[69,75,76]).

PATHOGENESIS

There are two ways in which the virus of lymphogranuloma venereum may reach the rectal wall.

In the first instance,[2,3,27,28,41–44,48,61,80] the rectal involvement is secondary to a primary genital lesion. Being of marked lymphotropic propensity,[36,45] the virus invades the regional lymph nodes soon after the appearance of the primary lesion and gives rise to an acute purulent lymphadenitis. The lymph nodes chiefly involved are the inguinal groups in the male and the pelvic groups—especially the anorectal group of Gerota—in the female. Retrograde lymphangitis and lymphatic stasis accompanying the pelvic lymphadenitis then carries the virus to the rectal wall. The action of the virus on the rectal tissues together with the lymphatic stasis and severe secondary infection gradually leads to the picture of chronic ulcerative proctitis and periproctitis.

The other mode of inoculation, much rarer, is the direct implantation of the virus into the rectal mucosa. This has been observed following abnormal sexual practices.[9,38,47,68,74]

From the rectum proper the pathological process may extend upward and involve continuous[57,60,65] or disseminated[20,56,76] segments of the large bowel or even the small intestine.[55,71]

PATHOLOGY

Much of the present knowledge of the gross pathology of inflammatory rectal stricture has been derived from clinical observations. Dependable reports of adequately studied and described operative and autopsy specimens are relatively scarce.[4,5,19,23,40,59,85,86] The earliest phase of

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the disease[67,84] is an acute purulent or mucopurulent proctitis which may be without distinguishing characteristics. Other early cases show a friable, granular, nodular, or furrowed surface with a thickened and resistant underlying wall. Later mucosal ulcerations appear, the parietal thickening becomes pronounced, the perirectal tissues become dense and rigid, and the diameter of the lumen becomes reduced. In the fully developed stricture, massive infiltration of the wall of the rectum and periproctic fixation are the outstanding characteristics. The lumen may reach any degree of narrowing and its course may become tortuous because of irregularities of the perirectal fibrosis. The mucosal lining is traversed by ulcerations or entirely replaced by granulation tissue. Proximally the surface changes abruptly into normal mucosa but the colonic wall may be hypertrophied and the lumen dilated. The periproctic fibrous connective tissue proliferation, which extends into the rectal wall and produces the tumor-like thickening, may be of such extent as to result in a "frozen pelvis." In this fibrous mass abscesses, fistulae and sinuses are frequent.

The important microscopic pathological features are the very marked connective tissue proliferation that appears to stream into the muscular layers from the direction of the perirectal tissues. Extensive inflammatory infiltrations are strikingly rich in plasma cells and are found along the fibrous bands as well as in the perivascular spaces. In addition, chronic abscesses, endophlebitis and endarteritis of varying degree, and ulcerative and purulent inflammation of the mucosa are present.

While the composite picture of the histopathological changes as seen in autopsy and operative specimens of the rectum is quite characteristic, the experience of others[14,46] and our own experience indicate that biopsy alone is inadequate for the diagnosis of rectal lymphogranuloma venereum. This is to be expected since the important histological alterations occur in the deeper layers of the rectal wall and biopsy specimens represent only the more superficial tissues. Biopsy is indispensable,

TABLE I

ONE HUNDRED AND SEVENTEEN CASES OF RECTAL STRICTURE

Etiological Classification		
Inflammatory	42	(35.8%)
Frei test: positive	28	
Frei test: negative	3	
Frei test: not done	11	
	42	
Post-irradiation	32	(27.3%)
Postoperative	22	(18.8%)
Congenital	8	(7.0%)
Ulcerative coloproctitis	5	(4.3%)
Incidental to extrarectal cancer	5	(4.3%)
Traumatic	2	(1.7%)
Incidental to pelvic cellulitis	1	(0.8%)
	117	(100.0%)

TABLE II

TWENTY-EIGHT CASES OF LYMPHOGRANULOMATOUS RECTAL STRICTURE WITH POSITIVE FREI REACTIONS

Summary of Clinical Characteristics		
Age (years)	Average	35.7
	Range	19–53
Duration (years)	Average	6.5
	Range	0.5–18
Sex	Male	0
	Female	28
Race	White	13
	Negro	15
Inguinal bubo	History	6
	Physical examination	1
Coincident syphilis	History	4
	Serology	5
Associated lesions	Frozen pelvis	3
	Esthiomene	5
	Fistulae	15
Length of lesion (22 cases)	5–10 cm.	11
	11–20 cm.	8
	21– cm.	3
Location of lesion (distance of lower end from mucocutaneous line)	Less than 3 cm.	1
	3 to 6 cm.	20
	7 to 8 cm.	1
Anal canal involvement		3

however, in eliminating other entities and as confirmatory proof.

ROENTGENOLOGICAL FINDINGS

To study the roentgenological features of rectal stricture all cases seen at the University Hospital in the fourteen year period ending February, 1940 (117 cases) were reviewed. These cases can be classified on the basis of etiology into various subgroups as indicated in Table I. Pertinent clinical data for the Frei-positive cases are summarized in Table II. The cases which were used for the roentgenological study are summarized in Table III.

Table III

LYMPHOGRANULOMA VENEREUM
(ANALYSIS OF 20 CASES)

															CLINICAL DATA										RADIOGRAPHIC FINDINGS									
INITIALS	NUMBER	SEX	AGE	RACE	MARITAL STATUS	OCCUPATION	LUETIC	HISTORY OF PRIMARY	HISTORY OF BUBO	DURATION OF SYMPTOMS	FREI TEST	LOCATION OF STRICT. FROM ANUS	ESTHIOMENE	TREATMENT	EXTENT	AVERAGE DIAMETER OF LUMEN	MINIMUM DIAMETER OF LUMEN	WALL	FISTULA OR SINUS TRACT	OBSTRUCTION TO EVACUATION	FLEXIBILITY OF WALL	SINGLE OR MULTIPLE AREAS	AXIS OF INVOLVED PORTION
D.M.	142 491	♂	21	W	S	IRON WORKER	NEG.	NEG.	NEG.	1 YR	NOT DONE	4 CM	0	COLOSTOMY	INDETERM.	INDETERMINATE	INDETERMINATE	INDETERM.	SINUS	NONE	INDETERMINATE	S	INDETERMINATE.
F.B.	248525	♀	32	W	M	HOUSEWIFE	NEG.	NEG.	NEG.	1 YR	NOT DONE	4 CM	0	COLOSTOMY	4 CM.	2 CM.	1 CM.	SMOOTH	NONE	PRESENT	RIGID	S	STRAIGHT
H.C.	299 806	♀	45	W	M	HOUSEWIFE	POS.	NEG. LUETIC CHANCRE	NEG.	12 YRS.	+	4 CM.	0	DILATATIONS	6 CM.	2.5 CM.	1 CM.	SMOOTH	SINUS	NONE	RIGID	S	STRAIGHT
J.S.	352 582	♀	52	W	M	HOUSEWIFE	NEG. HISTORY OF %	NEG.	NEG.	2 YRS.	+	4 CM.	0	DILATATION + FREI ANTIGEN	7 CM.	2.5 CM.	1 CM.	IRREG.	NONE	NONE	RIGID	S	CURVED
E.J.	357 531	♀	50	C	SEP.	HOUSEKEEPER	NEG.	NEG.	NEG.	15 YRS.	+	5 CM.	0	NONE	5 CM.	3 CM.	1.5 CM.	SMOOTH	NONE	NONE	RIGID	S	STRAIGHT
M.R.	376 322	♀	31	W	M	HOUSEWIFE	NEG.	NEG.	NEG.	2 YRS.	IN-DET.	4 CM.	0	NONE	7 CM.	3 CM.	1.5 CM.	IRREG.	NONE	NONE	RIGID	S	STRAIGHT
R.H.	380 566	♀	34	C	M	INMATE HOUSE OF CORRECTION	NEG. HISTORY OF %	NEG.	NEG.	10 YRS.	+	5 CM.	0	COLOSTOMY	10 CM.	3 CM.	.8 CM.	IRREG.	NONE	PRESENT	RIGID	S	STRAIGHT
N.W.	389 073	♀	49	C	SEP.	HOUSEKEEPER	POS.	NEG.	NEG.	10 YRS.	+	9 CM.	+	COLOSTOMY	10 CM.	2 CM.	1 CM.	IRREG.	NONE	PRESENT	RIGID	S	STRAIGHT
I.W.	394 151	♀	40	W	D	HOUSEWIFE	POS.	NEG.	NEG.	NOT STATED	+	5 CM.	0	ANTI-LUETIC	13 CM.	1 CM.	1 CM.	IRREG.	FISTULA	NONE	RIGID	S	STRAIGHT
L.R.	394 648	♀	46	W	W	HOUSEKEEPER	NEG.	NEG.	NEG.	9 YRS.	+	8 CM.	0	FREI ANTIGEN	8 CM.	2 CM.	1.5 CM.	IRREG.	SINUS	NONE	RIGID	S	CURVED
V.W.	401 045	♀	45	C	W	ROOMING HOUSE PROPRIETOR	NEG. HISTORY OF %	NEG.	POS.	7 YRS.	+	4 CM.	0	COLOSTOMY	11 CM.	.5 CM.	.5 CM.	IRREG.	FISTULA	PRESENT	RIGID	S	CURVED
A.J.	409 906	♀	45	C	SEP.	INMATE HOUSE OF CORRECTION	NEG.	NEG.	NEG.	18 YRS.	+	5 CM.	+	NONE	12 CM.	3 CM.	1.5 CM.	SMOOTH	NONE	NONE	RIGID	S	STRAIGHT
G.P.	420 021	♀	31	W	M	HOUSEWIFE	NEG.	NEG.	POS.	9 YRS.	+	5 CM.	+	NONE	12 CM.	1.5 CM.	1.5 CM.	IRREG.	SINUS	PRESENT	RIGID	S	CURVED
V.L.	421 538	♀	37	W	S	CLERK	NEG.	NEG.	NEG.	5 YRS.	+	IN-DETERMINATE	0	FREI ANTIGEN	25 CM.	1.5 CM.	1 CM.	IRREG.	NONE	NONE	RIGID	S	STRAIGHT
E.H.	426 717	♀	19	C	S	NONE	NEG. HISTORY OF %	NEG.	NEG.	1⅛ YRS.	+	4 CM.	0	DILATATION	16 CM.	1.5 CM.	1.5 CM.	IRREG.	FISTULA	NONE	RIGID	S	STRAIGHT
R.D.	431 625	♀	27	C	SEP.	HOUSEMAID	NEG. HISTORY OF %	NEG.	POS.	7 MO.	+	IN-DETERMINATE	+	COLOSTOMY	4 CM.	2 CM.	2 CM.	IRREG.	FISTULA	PRESENT	RIGID	S	CURVED
E.S.	433 364	♀	48	W	M	MACHINE OPERATOR	NEG.	POS.	NEG.	10 YRS.	+	" DIFFUSE	0	DILATATIONS	8 CM.	1.5 CM.	1.5 CM.	IRREG.	SINUS	NONE	RIGID	S	CURVED
M.S.	434 487	♀	42	W	M	HOUSEWIFE	NEG.	NEG.	NEG.	8 YRS.	+	5 CM.	+	COLOSTOMY	8 CM.	3 CM.	.8 CM.	SMOOTH	NONE	NONE	RIGID	S	STRAIGHT
M.S.	447 910	♀	29	W	S	UNEMPLOYED	NEG.	NEG.	POS.	12 YRS.	+	3 CM.	0	COLOSTOMY	22 CM.	2 CM.	1.5 CM.	IRREG.	FISTULA + SINUS	PRESENT	RIGID	S	STRAIGHT
C.B.	438 244	♀	30	C	M	HOUSEWIFE	NEG.	NEG.	NEG.	7 YRS.	+	4 CM.	0	SULPHANILAMIDE	9 CM.	1½ CM.	.8 CM.	IRREG.	FISTULA + SINUS	NONE	RIGID	S	STRAIGHT

Brief descriptions of the roentgenographic findings in inflammatory rectal stricture are available in several case reports[10,11,15,16,17] which point out and discuss varying degrees and extent of narrowing of the rectum and distal colon. One instance of stenosis of the rectum, together with a second and separate stricture at the rectosigmoid junction, was described by Mallory.[56] A detailed report of a case with three separate colonic lesions on a common basis of lymphogranuloma venereum has been given by David and Loring.[20] Spiesman *et al.*[76] reported one case of lymphogranuloma venereum involving the terminal ileum and colon.

Method of Study. The material selected for roentgenographic analysis comprises 20 cases, 17 with positive and 3 with the presumptive diagnosis of lymphogranuloma venereum, representing all the cases of the inflammatory group (Table I) with adequate roentgenologic studies. It is believed that this series offers a reliable sample of the disease in all its manifestations of practical

Fig. 1. (No. 394155.) A rectovaginal fistula permitted filling of the vagina. All the rectum and distal sigmoid is narrowed uniformly; no rectal pouch exists. There is a tapered junction between narrowed and normal calibered sigmoid colon. The pelvic colon retained a uniformly fixed appearance in several exposures.

importance as judged not only from our own material but also from other reported cases. The roentgenograms of these cases were carefully reviewed and the characteristics of the abnormal findings noted and compared with other lesions of the colon, especially those which produce constriction of the rectum such as rectal and sigmoid carcinoma, diverticulitis, and various types of chronic ulcerative colitis, and post-irradiation bowel stenosis. Other constricting lesions of the rectum were also studied in order to obtain a sufficiently large sample to include all possible entities.

These cases were investigated roentgenographically by means of the usual barium enema with roentgenoscopic observation during injection of the contrast material. In several instances spot films were made

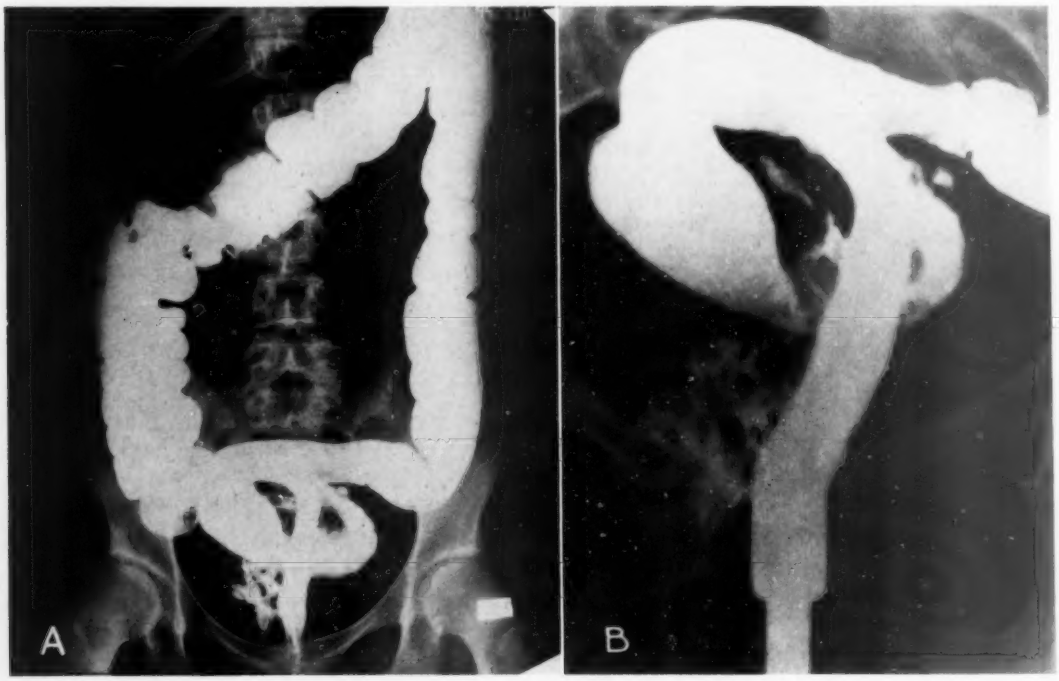

Fig. 2, *A* and *B*. (No. 447910.) Barium enema shows extensive constriction of the rectum with multiple sinus tracts projecting laterally from the rectum. One of these was proved by injection of iodized oil (separate examination) to communicate with a fecal fistula opening on the anterior abdominal wall.

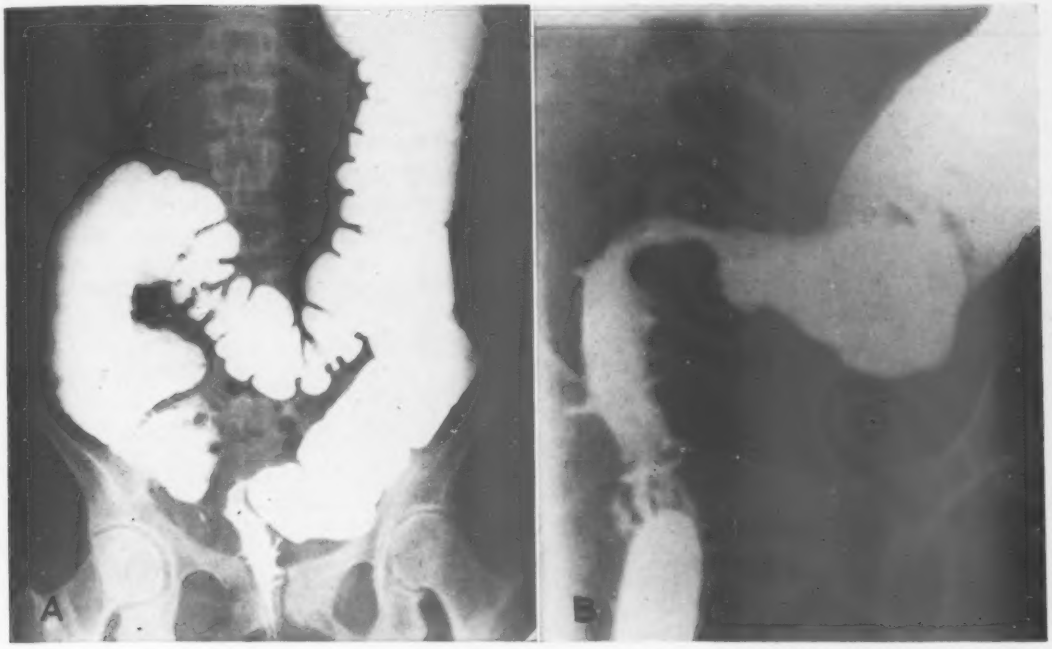

Fig. 3, *A* and *B*. (No. 420021.) There is marked tubular narrowing of the rectal lumen with several sinus tracts extending into perirectal tissues and communicating with the rectal lumen. The oblique film made at the fluoroscope shows absence of overhanging margins at the upper end of the involved area. There was very little emptying of the proximal colon seen in the postevacuation film. The proximal colon is dilated.

at the fluoroscope to show the deformed segments. All cases had films of the full abdomen obtained before and after evacuation of the enema fluid. In many instances additional exposures were made with double contrast technique using air injected into the colon.

In all cases of lymphogranuloma venereum the abnormal findings (Table III) were limited to a single segment of the colon; the disease always started in the rectal pouch and extended upward for a variable distance. There was marked narrowing of the rectal ampulla. As projected on the film the narrowest portions may measure only 0.5 cm. (the variations of this measurement as well as other numerical values are given in Table III). Constriction to the extent of a filiform lumen has been described by others but was not observed by us. The walls of the rectum were fixed and immobile (Fig. 1), as seen at the fluoroscopic screen and in multiple films and were very shaggy, irregular, and had fine surface ulcerations along their margins (74 per cent of cases). Many of the ulcerated areas communicated by fistulous tracts with the vagina, the perineum, or the anterior surface of the abdomen (Fig. 1, 2, *A* and *B*). In other instances, there were sinus tracts which communicated between the perirectal tissues and the ulcerated segment of the rectum (Fig. 3, *A* and *B*). Less commonly (26 per cent), the rectum was markedly and uniformly narrowed, but its walls were smooth (Fig. 4). Usually the inflammatory process was limited to the pelvic colon but occasionally (3 cases in this series) the sigmoid was involved as it rose out of the true pelvis. In one case the involvement extended to the lower descending colon (Fig. 5). The junction of normal and abnormal portions was poorly defined because of a tapering of the constricted portion to gradually approximate the caliber of the normal colon. The estimation of the total length of the involved segment was therefore not very accurate. With this

Fig. 4. (No. 299904.) Tapered narrowing of the rectal ampulla is present. A single small-sized sinus tract projects to the left at the level of the pubic symphysis. The rectum is quite straight. Its walls are smooth.

limitation in mind, however, as far as could be determined the length of the segment involved varied from 4 to 25 cm., with an average of 10 cm.

The appearances below the stricture may be misleading. One may believe at first that the narrowed portion can be traced directly to the mucocutaneous junction. As clinical examination will readily show, this is not usually the case since a free lumen of varying length can be palpated below the lower limit of the stricture. For roentgenological determination of the anal orifice, an accurately placed marker is necessary.

Fig. 5. (No. 421536.) Film shows extensive tubular narrowing of the rectum, sigmoid, and lower descendens. Numerous fine serrations are present along the margins in the constricted portion. Colon above is normal.

Fig. 6. (No. 456244.) Lateral view shows barium filling of the rectum, vagina, and several sinus tracts leading front and back from the rectal canal. Note the very irregular outline of the rectal wall. The vagina was filled through a fistula connecting with the rectum.

The course of the strictured region was

usually straight but occasionally (30 per cent of cases) it may be curved. Due to the two-dimensional character of non-stereoscopic roentgenograms the estimation of this attribute is somewhat inaccurate; lateral views, which we obtained in some cases, would easily overcome this difficulty (Fig. 6).

Even though the narrowing of the rectal lumen may be severe, the obstruction encountered during the injection of the contrast fluid, while at times considerable, never became impassable. On the other hand, there was definite interference with the voluntary evacuation of the barium enema in more than a third of the cases as judged by the amount of barium shown in the post-evacuation film and the dilatation of the uninvolved portion of the colon.

Briefly then, the salient features that seemed to delimit these cases from inflammatory lesions seen elsewhere in the alimentary tract were the unusually marked reduction of the lumen, and the presence of fistulae and sinus tracts.

Roentgen Differential Diagnosis. The deformity of the colon due to heavy pelvic irradiation resembles very closely those cases of lymphogranulomatous rectal stricture with a smooth mucosal surface such as is illustrated in Figure 4. There are some distinguishing features, however. Sinuses or fistulous tracts are never found. The constriction is usually just above the usual site of lymphogranulomatous stenosis.

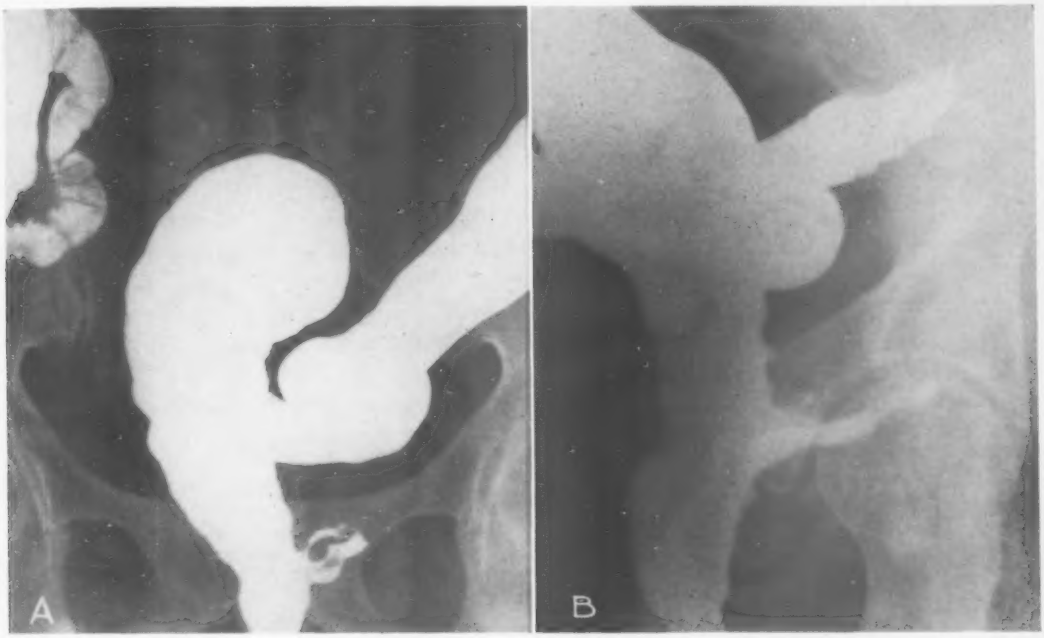

Fig. 7, *A* and *B*. (No. 394648.) Films show fusiform narrowing of the rectum with a large branching sinus projecting to the left of the rectum and smaller ones leading from the right. All margins of the rectal wall are irregular. There is generalized fixation of the rectum as seen in several exposures.

When the constriction is extensive enough to involve the rectal ampulla, then it is indistinguishable from lymphogranuloma venereum on purely roentgenographic evidence. Needless to say, the clinical history quickly identifies these cases.

Chronic ulcerative colitis, idiopathic type, in its typical roentgen manifestations, presents no differential diagnostic problem since the involvement is diffuse and there are no circumscribed narrowed points. In exceptional cases where there is a limited portion of the colon involved, associated with a rectal stricture, the Frei test must be performed for definite diagnosis. Like-

Fig. 8. (No. 433394.) The rectal ampulla has lost its normal outlines and is reduced in size. It has a finely ulcerated margin. Minute sinuses extend to the right of the proximal rectum.

wise, the Frei test and biopsy are necessary to exclude those rare instances of amebic and tuberculous colitis which are accompanied by rectal stricture.[39,73,82,83]

In this study we found no cases of segmental colitis or enteritis associated with rectal stricture. One must bear in mind, however, that cases have been reported in which the virus of lymphogranuloma venereum was believed to be the causative agent in cases of this type whether or not rectal stricture was present.[12,13]

The sharp overhanging edges, annular constriction, and filling defects produced by carcinoma as a rule permit easy exclusion of this lesion. In addition to the lack of sharp demarcation, inflammatory stricture involves a longer segment of bowel than would be expected of intrinsic neoplasm. Extrinsic pressure deformity caused by space occupying pelvic diseases does not result in mucosal ulceration nor in fistulae or sinus tracts. Instead, there is usually displacement of a segment of pelvic colon resulting in non-tubular and asymmetric constriction if any is present at all.

Postoperative stricture usually involves the rectal canal at a point too low to be delineated on roentgenograms. The rectal ampulla is of normal caliber or even larger than normal in these cases.

Occasional cases of congenital narrowing of the rectum in which an imperforate anus had been treated surgically were seen in infants. The rectum is perfectly normal except for a well demarcated channel of varying length and caliber formed by the surgeon.

No one will seriously confuse bulbous diverticula with the narrow, tapered sinus tracts seen in rectal stricture, the two being obviously quite different in their roentgenographic appearance.

DISCUSSION

The roentgenological changes observed in inflammatory rectal stricture due to lymphogranuloma venereum are relatively

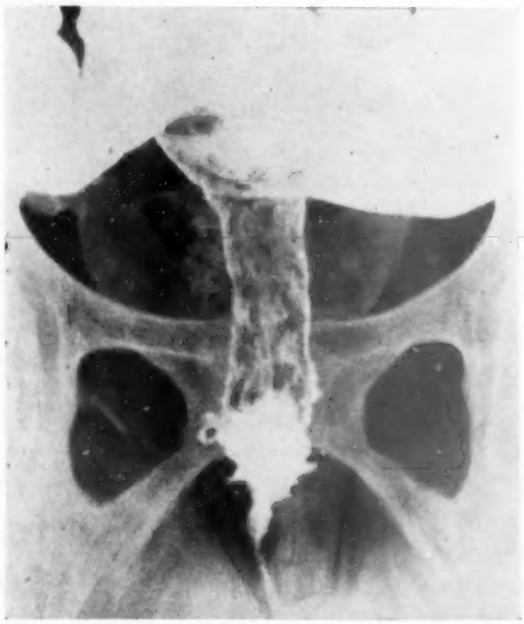

Fig. 9. (No. 389073.) There is marked reduction in caliber of the entire rectum, and colon above is dilated. Very little barium was expelled as seen in the postevacuation film. The rectum rises straight out of the pelvis and was fixed in position at roentgenoscopy and on all films.

simple and readily explained by the pathological process. One deals with an obstructive lesion which does not arise on the mucosa and project into the lumen, but which is produced by infiltration of the rectal wall by a chronic granuloma. The infiltration, step by step, brings about rigidity and thickening of the wall, and finally, constriction of the lumen. Hence, the absence of intraluminal mass or masses. The mucosal ulceration, which progresses hand in hand with the thickening of the wall, explains the shaggy appearance of the narrowed lumen. In those relatively few cases where the luminal surface appears roentgenologically smooth, the ulceration is so advanced that the mucosa may be entirely replaced by granulation tissue which may be firm and may give the appearance of pseudomucosa even sigmoidoscopically.

The lack of sharp demaraction between normal and abnormal portions of the bowel is in seeming contradiction to direct pathological observations. The contradiction, however, is not a true one and is explained by the mechanical conditions created, that is, by the necessity of a gradual flaring out of the bowel wall because of its flaccidity from the upper part of the stricture toward the uninvolved portion. This transitional segment obscures the sharp delineation of the limits of the stricture. It also explains the "cone-like" configuration in the marginal portions of the stricture mentioned in some reports[76] but never found by direct examination.

Our study has dealt exclusively with the fully developed picture of inflammatory rectal stricture. Some variation in luminal diameter can be observed but it is relatively limited. One must bear in mind, however, that stenosing proctitis of venereal lymphogranulomatous origin is being observed in increasing numbers and that rectal strictures of large caliber may come under the roentgenologist's observation in which, of necessity, the characteristics may be less marked than, or even different from the criteria enumerated above.

The fact that lymphogranuloma venereum of the rectum is not a stationary disease has an important bearing on the roentgenologist's work. Activity of the disease, as judged by its spread in the long axis and in the changes of the free lumen, can best be checked by repeated roentgen examinations. Both this consideration and the information regarding the character of the lumen, its tortuosity, its accompanying sinus tracts and the length of the involved portion make careful and multiple roentgenographic investigations indispensable in the adequate management of these cases. Cases have been reported[84] where the site of colostomy, to relieve obstruction caused by inflammatory rectal stricture, was improperly selected because of failure to investigate the extent of the stenosed portion of the bowel.

In considering the three-dimensional extent of the involvement, one must bear in mind the magnification of the image inherent in all roentgenograms. As seen in films, the degree of narrowing of the lumen is usually less marked than is reported from

Fig. 10. (No. 376322.) There is reduction in caliber of the rectal lumen with fine irregular marginal ulcerations. The central axis of the rectum is nearly straight.

direct examination; obviously so because of the enlarged shadow cast by the divergent roentgen beam. Some of this distortion may be obviated by the employment of a catheter marked at regular predetermined intervals with a radiopaque substance.[1]

Our data sufficiently emphasize the striking restriction of the lesion to a fairly limited segment of the colon. While this is true in the majority of cases reported elsewhere, many instances of spread of the lesion to the sigmoid or to other segments of the colon have been reported. Such involvement is usually by direct continuity,[6,22,24,35,50,54] but some evidence has been presented for disseminated lesions, allegedly of lymphogranulomatous venereal origin, in isolated segments of the colon and ileum with[71] or without[12,23] rectal pathology. It is well to keep in mind these possibilities when dealing with stenosing segmental inflammations of these portions of the alimentary tract.

Roentgen examination in these cases is somewhat difficult. Many patients have had numerous operations about the rectum; they may have poor sphincter control; they are often weak and emaciated. Stenosis of the rectum makes insertion of the enema tip difficult, and when the injection is started, the nozzle is easily dislodged. The use of a self-retaining catheter is of considerable help in such cases.

SUMMARY AND CONCLUSIONS

1. Some of the pathological and roentgenological problems of rectal lymphogranuloma venereum have been surveyed.

2. The roentgenological findings in lymphogranulomatous venereal rectal stricture are those of a severe inflammatory disease of the rectum; it is distinguished from other etiological agents by the degree of constriction in this location, and by the presence of fistulae and sinus tracts. When these attributes are present, the roentgenological findings will usually give the correct diagnosis because other inflammatory processes which might cause confusion are exceedingly rare.

We wish to express our appreciation of the suggestions and criticisms of Dr. F. J. Hodges, Professor of Roentgenology, and Dr. Carl V. Weller, Professor of Pathology, University of Michigan Medical School, Ann Arbor, Michigan.

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CARCINOMA OF THE BREAST

REPORT OF A CASE TREATED BY SURGERY AND IRRADIATION; SEVENTEEN YEARS' DURATION*

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CANCER of the breast is one of the most common and important conditions in the domain of malignant diseases, and often shows most disastrous results due to injudicious therapeutic procedures instituted at the time the malady is recognized. A complete, thorough, careful physical examination, and all necessary laboratory examinations should be done in each and every case of cancer before any form of therapy is considered. If possible, every case should have roentgenograms made of the chest and pelvis, including the lumbar spine and heads of the femora.

There is no one fixed therapeutic procedure for every case. Each one should be individualized and the therapeutic measures adopted which will give the best possible result for that particular type of condition.

Most surgeons will admit that the peak of skill and technique in radical surgery of the breast has been attained, and yet the results by surgery alone in cancer of the breast are still unsatisfactory.

There is no longer any doubt that radiation therapy is an important adjunct in the therapeutic armamentarium of cancer of the breast.

In order to outline the proper plan of attacking cancer of the breast, there are many important factors to be borne in mind, such as the age of the patient, clinical appearance of the growth, size, extent, duration, fixation or moveability, presence of metastases, general condition, association conditions, laboratory aids, etc.

Rarely is there indication for immediate so-called emergency radical breast amputation surgery as occurs in acute appendicitis or other acute intra-abdominal surgical conditions. Too often we obtain a history of urgent immediate radical surgery of the breast followed within a comparatively short time by postoperative diffuse metastases and early death, which would most likely not occur so soon were the condition even unrecognized for the time being.

Though it is essential and important to decide whether a malignant growth in the breast is operable or inoperable, all the other factors enumerated and associated conditions are to be considered before surgical measures are to be instituted.

It is not sufficient to possess the necessary surgical skill, but it is equally important to have the proper surgical judgment in deciding when to operate, whether to combine it with pre- or postoperative irradiation or other measures.

In some cases immediate surgery may hasten death whereas more conservative temporary measures such as radiation therapy, followed at a later date by perhaps less radical surgery, may cause prolongation of life in comfort for many years.

REPORT OF CASE

H. R., female, aged forty-one, married, was referred to me on March 21, 1925, about sixteen years ago, with the following history:

She had been married about eighteen years, two children, sixteen and fourteen, both breast fed—no miscarriages. Menstruation started at the age of fourteen, regular seven days' duration up to six months ago, since then irregular every two to three weeks, profuse and painful, last period March 13. She had an abdominal abscess operation and gynecological vaginal operation three and four years ago.

Present Illness. Patient was admitted to Lebanon Hospital February 27, 1925, with a history of dull, constant pain in the right breast and presence of a lump, size of walnut, which was increasing in size. Pain was in region above

* Presented at meeting of Alumni Society of Lebanon Hospital, Dec. 10, 1940.

the nipple of the right breast. Two weeks prior to admission she noticed two small lumps in lower half of right breast and pain extending to this area; no bleeding from nipple. Complained of weakness on slight exertion. On physical examination, the right breast showed presence of three small lumps, one situated above the nipple, size of a small egg, rubbery in consistency, freely moveable, not attached to the skin or underlying chest wall, slightly tender, the other two small masses below the nipple each size of a walnut, tender, same consistency and moveable. A mass of matted glands in right axilla, tender, rubbery, not freely moveable on underlying chest wall—mass the size of an egg. Left breast was negative, heart and lungs negative. Abdomen showed operative scar in infraumbilical region. Extremities showed superficial varicosities. Diagnosis was carcinoma of right breast with axillary metastases. Blood and urine examinations were negative. Roentgenogram of chest was negative. Right radical mastectomy was done on February 28, 1925, by Dr. Henry Roth. Gross pathology revealed in the right breast a tumor mass the size of hen's egg in upper outer quadrant of the breast, and a number of palpable lymph nodes in the axilla.

Pathological report showed adenocarcinoma of the breast with metastases in the axillary glands. Discharged from the hospital on March 8, 1925.

On March 21, 1925, the patient consulted me at my office, about three weeks after a right radical mastectomy. Roentgenogram of chest was reported as negative, but she complained of pains in the lower lumbar spine, radiating down the right thigh, present since the operation. No roentgenograms of pelvis and lumbar spine were taken. Physical examination showed her in good general condition and local examination revealed a postoperative scar over right mammary region. Menstrual periods were still present, the last on March 13, 1925. From March 21, 1925, to May 13, 1925, she received a course of deep roentgen therapy to the right mammary region and mediastinum through four portals, anterior, posterior, left and right lateral (200 kv.), at 50 cm. distance, 5 ma., filtration 0.5 mm. Cu plus 1 mm. Al, thirty minutes each, and a course of therapy to the pelvis and lumbar spine through four portals, anterior, posterior, left and right lateral. From July 1 to July 15, 1925, three additional roentgen treatments were given to the lower lumbar spine, on account of pain and tenderness which were present. Last menstrual period was June 6, 1925—one week duration. From November 25, 1925, to January 11, 1926, another cycle of roentgen therapy was given to the right chest and mediastinum. On March 2, 1927, the patient appeared for examination, in good condition, no symptoms; she had had no menstrual periods for about two years. There was a large hard swelling over right sternochondral region, tenderness over left intercostal space and rib and breast. Another series of roentgen treatments was given to the chest from March 2 to March 26, 1927. From December 13, 1927, to January 10, 1928, the patient was given six roentgen treatments to the pelvis, three anteriorly and three posteriorly. From September 24 to November 2, 1929, another cycle was given to the right mammary region and mediastinum.

On September 19, 1938, about fourteen years after a right radical mastectomy, the patient, now being about fifty-four years of age, was admitted to the Lebanon Hospital complaining of a lump in the left breast, of three weeks' duration, frequency of urination and dizziness. For the past year she has had hypertension, polyuria, nycturia, pains in back, and dyspnea. Physical and laboratory examinations showed signs of cardiorenal disease with hypertension. Examination of chest anteriorly presented postoperative scar on right side. Left breast presented a hard, slightly tender mass in outer upper quadrant, size of a small apple, deep in the tissue of the breast, nipple retracted, gland palpable, hard, in left axilla. Surgical procedure was contemplated, but upon consultation I advised a course of preoperative irradiation to be followed by surgery. The diagnosis at this time was carcinoma of the left breast with metastases to axilla; cardiorenal disease and hypertension.

From October 1 to October 27, 1938, roentgen therapy was administered to left lateral chest and axilla (2,400 r) and from October 28 to November 17, to left anterior chest (1,800 r). Examination of left breast after therapy revealed almost complete regression of tumor mass in breast. On June 13, 1939, about seven months after completion of radiation therapy and regression of the tumor mass in the left breast, the patient was admitted to Lebanon Hospital complaining of a mass and severe pain in left breast and weakness. Physical examination revealed a hard, nodular mass in upper outer quadrant of left breast, tender, retraction of the nipple, skin adherent, mass ex-

tending into axilla and tenderness in the axilla, fixed to the chest wall. Dr. Henry Roth excised a section of the breast, 2 inches in diameter, containing a hard infiltrating nodule, under local anesthesia, drained and closed the wound. Pathological report was infiltrating carcinoma simplex of breast.

Roentgenogram of the chest showed rounded left ventricle of the heart with prominent arch of the aorta. No evidence of metastases in the lungs but small cystic areas of degeneration in outer end of right clavicle. Further roentgen therapy was advised and begun on July 17, 1939. On account of pain and tenderness present in right lateral chest since operation, irradiation was given to that region (1,200 r in six treatments). July 17 to August 4, 1939, roentgen therapy was administered to the left anterior chest (2,000 r in ten treatments).

The mass in the breast showed regression in size and became moveable. On March 5, 1940, the patient was admitted to the Lebanon Hospital with a hard mass, size of a lemon, in the left breast, diagnosis of carcinoma with axillary metastases. On March 12, 1940, left mastectomy was done by Dr. Henry Roth. The entire breast was removed down to the pectoralis major, fascia over the pectoralis major was removed, also an enlarged gland in the left axilla was excised. Roentgenogram of the chest on March 7, 1940, was reported as no metastases, but a few cystic areas of bone absorption in acromial end of the right clavicle. Pathological report was recurrent carcinoma simplex of the breast with metastases in the axillary glands; discharged from the hospital March 23, 1940.

On April 27, 1940, patient appeared complaining of pain in right anterior chest, and in left hip, extending down left thigh. Roentgenogram of pelvis and left hip was taken but showed no definite evidence of metastases.

On April 27, 1940, roentgen therapy was given to the right anterior chest, due to pain and tenderness present, which subsided after four treatments (total of 1,200 r) ending on May 7, 1940. Radiation therapy was given to the left anterior chest and left lateral chest and axilla (1,200 r each). In spite of the fact that there was no definite evidence of metastases in the pelvis and hip, due to persistent pain present, 1,200 r was given to the left hip with marked improvement and subsidence of the pain.

The patient when seen on June 18, 1940, was in good general condition and comfortable and complained of no pain.*

Comment. The case reported presents the following interesting features:

1. The patient is still alive and in apparent comfort for over seventeen years following carcinoma of the breast with glandular metastases, treated primarily by surgery and irradiation.

2. The occurrence of a cancer in the left breast about thirteen years after the malignant growth in the right breast, though of similar pathology, seems to me to be that of another primary malignant neoplasm. I believe such to be the case because in an individual with a history of malignant neoplasm there is a predisposition and inherent likelihood of another neoplasm to develop sooner than in one without such a history. The fact that thirteen years has elapsed without evidence of local recurrence or other metastases such as usually occur within a few years after onset, together with the clinical picture of the condition in the left breast, gives me the impression that this patient presents two distinct primary processes.

3. In my opinion, the radiation therapy administered to the pelvis and lumbar spine with production of castration had a favorable influence on the course of the disease in producing prolongation of life in comfort.

4. From my experience in the clinical course of cancer of the breast, I feel it is of considerable advantage in those cases with metastases, in the female who still has a menstrual cycle, to produce a castration by roentgen therapy.

5. The value of radiation therapy in an inoperable condition, which was later rendered operable, is exemplified in this case.

6. With the clinical evidence of pain and tenderness, which are persistent, even without definite roentgenologic evidence of metastases, radiation therapy is of value

* The patient is still alive and was last seen on April 15, 1942. During the past year she has been receiving local radium applications to areas of localized pain and tenderness over the lower anterior ribs, with marked relief, and she is still apparently comfortable.

in relieving such symptoms with possible prevention of development of skeletal metastases.

7. A patient with cancer of the breast after a definite plan of therapy is completed should be kept under observation and receive monthly examinations for at least two years. After this period such patient should be examined every six months in order to detect if possible any recurrence, metastases, or other primary growth.

8. Best results in the management of cancer of the breast will undoubtedly be obtained by the proper consultations and cooperation between physicians, surgeons, and radiation therapists who make complete, thorough, careful examinations of these patients and consider the numerous factors of importance before adopting any therapeutic procedures and individualize each and every case.

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THREE AND FIVE YEAR END-RESULTS IN THE TREATMENT OF CARCINOMA OF THE CERVIX AT THE AMERICAN ONCOLOGIC HOSPITAL*

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DURING the ten year period ending January 1, 1941, 151 cases of carcinoma of the cervix, which have been followed for three or more years, were treated at the American Oncologic Hospital. Three of these patients were treated by surgery alone and 6 had pathological diagnoses which could not be confirmed by our pathologist, Dr. Joseph McFarland. The remaining 142 cases form the basis for this study.

GRADATION FROM A PATHOLOGICAL STANDPOINT

Only cases with a proved pathological diagnosis were included. Seven were diagnosed as primary adenocarcinoma of the cervix and the remaining 135 cases were all classified as squamous cell carcinoma.

Broders[1,2] and Martzloff[4,5,6,7] emphasized the variation in the histopathological picture of squamous cell carcinoma of the cervix. It was thought that this variation might be utilized in determining the sensitivity of the tumors to irradiation and also in determining the prognosis of the patients.

On this basis, in Grades 1 and 2, "spinal cell cancer," are placed tumors in which most of the cells are mature and well differentiated. The cells are unusually large with well defined borders and resemble the cells seen in the upper layer of squamous epithelium. Large nuclei are usual but the nuclei seem small because of the abundance of cytoplasm. Epithelial pearl formation is common and mitotic figures are rare. This grade of tumor is supposed to be rather slow in growth but rather resistant to irradiation.

Tumors whose cells resemble those of the middle zone of cervical epithelium are placed in Grade 3 (transitional cell type). The cells usually are round or cuboidal with ill defined cell membranes. The nuclei seem larger in comparison to the amount of cytoplasm. Epithelial pearl formation is not a prominent feature but mitotic figures are more common. This grade of tumor is more rapid in growth but is more sensitive to irradiation.

Tumors whose cells are closely packed, usually oval shaped with large nuclei and practically no cytoplasm, are placed in Grade 4 ("spindle cell type"). Mitotic figures are more common and epithelial pearl formation is rare. This grade of tumor does not closely resemble any of the layers of normal epithelium but is more like the basal cell layer than the other two layers. The tumors are very rapid in growth and are considered to be more sensitive to irradiation.

Many of the cases in this survey had repeated biopsies and occasionally two or more were from different portions of the same tumor, taken at the same period of the disease. It was found rather frequently that specimens from the same tumor could be graded from 1 to 4 depending upon the area of the tumor from which the specimen was taken. And then again, specimens taken at different stages of the disease from the same patient could often be anywhere from 1 to 4. Moreover, it should be borne in mind that there may be a great individual variation in the grading of tumors. Thus, because of the frequent disagreement in grading from a histopathological point of view, it was thought best not to emphasize the pathological gradation of the tumors studied in this series of cases.

* From the Gynecology Service of Dr. S. E. Tracy and the Radiology Service of Dr. W. S. Newcomet. Presented at the meeting of the Wainwright Tumor Clinic Association, Philadelphia County Medical Building, May 7, 1941.

CLINICAL GROUPING

We therefore considered the local extent of the growth when first seen to be the main prognostic factor. There are two main groupings in use at present, the one originally suggested by Schmitz[10,11] and the grouping agreed upon by the Radiological Commission of the League of Nations in 1929. A comparison of these groupings is given below:

Group I-Schmitz—A nodule or ulcer on cervix, usually not more than 1 cm. in diameter. Diagnosis definite only with microscope.

League of Nations—Growth limited to cervix, uterus mobile.

Group II-Schmitz—Invasion of paracervical tissues, growth extends to the periphery of the cervix in either a horizontal or transverse plane. No uterine fixation or parametrial involvement.

League of Nations—Growth spreading into the fornices with or without parametrial involvement.

Group III-Schmitz—Carcinoma has invaded one or both parametria and the tumor as a whole is fixed.

League of Nations—Definite parametrial infiltration. Vaginal involvement with uterine fixation.

Group IV-Schmitz—Cancer has caused (*a*) fixation of tumor mass; (*b*) invasion of vaginal walls, vesicovaginal septum, bladder or rectum; (*c*) distant metastases.

League of Nations—More advanced local extension or remote metastases.

The international grouping differs from the Schmitz grouping in that it includes movable parametrial involvement of one side in Group II, and fixation of the parametrium of one side in Group III. The Schmitz Group II includes invasion of the cervix and paracervical thickening; Group III, invasion of one or both parametria, and Group IV, fixation of one or both parametria, or invasion of vagina, bladder and rectum, or systemic dissemination. The Schmitz grouping appears more logical in its definitions, and is more widely used in this country so it has been selected for use in this survey.

In addition to the usual description of the clinical findings in each case, an anatomical chart is utilized for each patient to demonstrate more graphically the amount of involvement present at the patient's first visit.

These cases were chosen without selection, the only prerequisite being that there should be a proved pathological diagnosis.

PLAN OF TREATMENT

The plan of treatment, in general, was as follows:

An intra-uterine application of radium was given first. The radium is contained in tubes of 50 mg. each. Each tube is 30 mm. long and 2.3 mm. in external diameter with a wall thickness of 0.5 mm. of platinum. The tubes were placed in tightly fitting brass capsules (1 mm. in wall thickness), and then covered with 1 mm. of soft rubber. In the majority of cases two 50 mg. capsules were placed in tandem formation in the uterus, sutured with chromic catgut to the cervix, and allowed to remain in place for ten to thirty-six hours (most often twenty-four to thirty-six hours), depending upon the age and condition of the patient. In all cases the bladder and rectum were each protected by two 2 mm. lead shields, each covered by 2 mm. of plastic composition rubber and molded to fit the anterior and posterior vaginal walls. The lead shields were separated by tightly packed gauze to give added distance. An inlying catheter is not utilized since it is felt that a bladder which is kept constantly empty would be more likely to receive the radiation effect from nearby radium than would a bladder which is allowed to fill normally.

When the reaction had subsided, about three to six weeks following the application, another radium treatment was given. This time, the two 50 mg. tubes of radium were placed in the 1 mm. brass capsules and then covered together with a 1 mm. lead mold. This mold was then wrapped in a 1 cm. thickness of cotton gauze and the tubes were placed across the face of the cervix. The radium was allowed to remain in place

about the same length of time and, as before, the bladder and rectum were each protected by 4 mm. of lead and 4 mm. of rubber.

Following the second radium application the patients were given a course of deep roentgen therapy. The method of irradiation was as follows: Roentgen rays, generated at 200 kv., with a Thoraeus filter, were applied at a distance of 70 cm. to each of four pelvic portals, two anterior oblique and two posterior oblique. The size of the portals was either 8 by 10 cm. or 10 by 10 cm.

In suitable cases a filter of 1 mm. of copper and 1 mm. of aluminum was used and occasionally a 50 cm. skin distance was employed. In excessively obese patients two lateral fields were sometimes added and, in cases needing it, small perineal fields were utilized. At present the tendency is for smaller fields with more attention being devoted to the direction of the central ray so that a greater dosage may be delivered to the tumor area with less irradiation of surrounding tissues.

Daily treatments of 300 to 600 r (measured in air) were used, alternating the fields so that a given area was exposed every fourth day. Each field received a dosage of from 1,800 to 2,400 r, the total dosage depending upon the rapidity with which the treatment was given and the general reaction of the patient to the irradiation.

However, in a fairly large percentage of the Group IV cases, it was not feasible to give the radium treatment first. These patients either had (*a*) ulcerated, markedly infected cervices or (*b*) cervices that had been so altered by disease that it was impossible to accurately determine the position of the cervical canal. Inasmuch as it is not believed desirable to place radium in close proximity to infected tissue as in (*a*) and since it would not be possible to implant radium in the endometrial cavity as in (*b*), roentgen therapy was given first in these cases in the usual manner.

In none of the patients treated were there any distressing symptoms from the radium therapy. In a very few of the patients, mild nausea and diarrhea resulted from the roentgen treatments; for these patients a longer period of time was necessary but all received the planned total of roentgen therapy.

It has been our experience that radium therapy, when given in the presence of pelvic inflammatory disease, results in flare-up of the condition. Therefore, in patients who have carcinoma of the cervix with an associated salpingitis, a course of roentgen therapy, cautiously given, is the treatment of choice.

After the original series of roentgen therapy had been given, as a general routine, with the average patient, the handling of the cases varied considerably, depending on the course of the disease in each case. When recurrence took place, which occurred more often in the parametrial region, they were treated with roentgen therapy since radium treatment would be attended by poor results in a large percentage of cases. Some of the patients have received two or three complete courses of roentgen therapy and are at present free from any clinically demonstrable evidence of carcinoma.

In a few of the cases, however, either because of untoward skin reactions to the roentgen radiation or because it was felt that the patient had received the utmost in roentgen therapy that was practical, the radium bomb has been used to advantage.

The radium bomb[8] at the American Oncologic Hospital, as originally designed in 1935, contained 4 grams of radium, made up in eighty tubes of 50 mg. each, each tube being 30 mm. long and 2.3 mm. in external diameter, with a wall thickness of 0.5 mm. of platinum. The tubes were placed in the bomb in a cartwheel formation with the ends of the tubes nearest the hub of the wheel, raised at an angle of 70 degrees. Densitometer readings with the radium in this position revealed no detectable variations with a 9 cm. field.

The bomb was most often employed at a 20 cm. skin distance, using a 10 cm. opening, treating one area anteriorly (10 by 10

cm. to 15 by 15 cm.) or one area posteriorly for one or two hours daily. Treatments were continued in most cases until at least 50,000 mg-hr. of teleradium therapy had been given. By the use of the bomb, a number of patients' lives have been prolonged comfortably over a considerable length of time. It is felt that this could not have been done with other methods at our disposal. A few of the patients treated have received a total dosage of more than 200,000 mg-hr. of teleradium therapy.

With the bomb, it is possible to carry enormous dosages of radiation into the body with very little skin damage. In all probability this may be explained on the basis of the observations made on the supervoltage roentgen machine by Trump[12] at the Massachusetts Institute of Technology.

Films were placed in the center of a pressed wood log and then exposed to low voltage roentgen rays. The radiation was directed toward the edge of the film so that a cross-fire effect resulted at the center. The first few centimeters of the film suffered severely. However, as the voltage was increased, the first few centimeters of film were affected less and less by exposure.

In describing methods used in the treatment of these cases, it is impossible to give any absolute routine. The amount of radium, roentgen radiation, or bomb therapy depended absolutely upon the character of the cases and the degree of tolerance of the patient to radiation. In some instances the radiation was given rapidly; in others it had to be delayed since irradiation is not accepted by all individuals in the same manner.

STUDY OF ACTUAL CASES

Of the series of cases, 98 have been followed for five or more years and 142 for three or more years.

The 5 Group I patients comprised 3 per cent of the total. These patients are all living and free from disease as far as can be determined clinically. Three of the patients have been living five years or more.

TABLE I
RESULTS—THREE YEAR SURVEY

Group	Number of Cases	Per Cent of Total	Survival	Per Cent of Survival
I	5	3	5	100
II	19	13	15	79
III	24	17	11	46
IV	94	67	22	23
	142		53	

Three year total survival rate (all groups) 37 per cent.

TABLE II
RESULTS—FIVE YEAR SURVEY

Group	Number of Cases	Per Cent of Total	Survival	Per Cent of Survival
I	3	3	3	100.0
II	12	12	7	58.0
III	18	18	7	39.0
IV	65	67	7	10.7
	98		24	

Five year total survival rate (all groups) 24 per cent.

There were 19 patients in Group II, 12 of them having been followed for five years or more. In this grouping we have a 79 per cent three year survival (15 patients) and a 58 per cent five year survival (7 patients).

In Group III there were 24 patients, 18 of whom have been followed for five years. Here we obtained a 46 per cent survival (11 patients) for three years, or a 39 per cent five year survival (7 patients).

Two-thirds of the patients fall into the Group IV classification and most of these were very far advanced cases. Thirty-five died within a year of their first visit to the Oncologic Hospital and 5 patients were not treated at all. These patients died within two months of being seen. The total five year survival in this grouping was 10 per cent, or 7 cases, and the three year survival was 22 cases or 23 per cent.

The five year survival rate for 98 cases, all groups, was 24 per cent and the three year survival rate for 142 cases, all groups, was 37 per cent.

CARCINOMA OF TNE CERVICAL STUMP

There were 10 patients who had had supravaginal hysterectomy prior to their first visits to the Oncologic Hospital.

Three of these patients were placed in the Group II classification. The hysterectomy had been done from three months to two years before their original visits to the Clinic. These patients all lived more than five years and one has lived ten years. It seems probable that the carcinoma of the cervix was present in these cases at the time of the hysterectomy, since in their histories, the patients all mentioned a vaginal discharge continuing from the time of their operation. This type of case, with the carcinoma being discovered within two years of operation, would be placed by some in the class of "coincident cases."

There were 7 patients in the Group IV classification. Four of these had had supravaginal hysterectomy within two years of their first visit to the Oncologic Hospital. One had been operated upon sixteen years previously and the other 2, five and seven years respectively. The onset of symptoms in the first 4 cases had begun prior to the hysterectomy and had continued despite the operation. The symptoms which brought the last 3 patients to the hospital were of less than three years' duration. Five of these patients lived less than one year, one lived a year and the other lived two years.

In 4 of these 7 cases the carcinoma of the cervix was undoubtedly present at the time of the supravaginal hysterectomy.

It has been pointed out by Jeanneny[3] that great care is necessary in applying radium in carcinoma of the stump because of the proximity of the intestinal loops. Phaneuf[9] emphasized the greater danger of the formation of fistulae after treatment because, by removal of the fundus uteri, a heavy source of filtration is removed.

In our cases the radium was placed across the face of the cervix in the usual manner but smaller repeated applications were employed.

It is interesting to speculate as to the part played by supravaginal hysterectomy in the course of the carcinoma. The patients who only had moderate involvement (Group II) when first seen, all lived more than five years. Perhaps the removal of the uterus and the elimination of the necessity for a lymphatic and blood supply to that organ helped to slow the spread of the disease so that a more favorable outcome resulted.

On the other hand, when the disease had progressed much farther before treatment was instituted, as in the Group IV cases, the results were uniformly bad. The removal of the uterus may perhaps retard the carcinoma in its early stages, but when parametrial involvement has taken place the absence of the uterus very possibly speeds the course of the disease.

It is evident that a careful visual and digital examination of the cervix is most necessary before performing a supravaginal hysterectomy which leaves the cervix as a potential source for future cancer.

FISTULAE

There were 13 patients who had either rectovaginal or vesicovaginal fistulae, or both. Four patients had fistulae on admission. Eight of the patients developed fistulae during the last few weeks of their terminal illness so the fistulae were most certainly due to carcinomatous extension. One case developed a vesicovaginal fistulae one month after she had received therapy. However, in this case, no protection was used for the bladder or rectum at the times that the radium was applied.

There are no cases, therefore, that might have developed fistulae due to our method of treatment.

CAUSES OF DEATH

In the patients who have died, it has not been possible to follow many with any great degree of accuracy. However, in those where the cause of death has been listed as other than carcinoma of the cervix, generalized metastases, or where more than one cause has been noted, pyonephrosis, hydronephrosis and uremia are frequently mentioned. It is quite possible that in some

cases, fibrosis resulting from radiation therapy has produced compression of the ureters and hydronephrosis just as effectively as has carcinomatous extension in other cases.

One patient originally sought medical attention at another hospital because of cough, dyspnea and hemoptysis. Roentgenograms of the chest were taken and the patient told that she had tuberculosis. However, about one or two weeks after this had been done, the patient complained that she had a rather foul-smelling vaginal discharge. A pelvic examination was done and extensive carcinoma of the cervix was found. The patient was then referred to the Oncologic Hospital. The patient died a few months later and at autopsy was found to have had extensive lung metastases, in addition to the pelvic findings.

The terminal cause of death in another case was pneumococcus pneumonia. The patient was apparently free from demonstrable carcinoma of the cervix at the time of death, nine months after she had received radium or roentgen treatment.

A Group III patient was treated at the Oncologic Hospital with two applications of radium, totaling 5,100 mg-hr. Following the last radium application there was no clinical evidence of carcinoma. Shortly after this the patient moved to another city and contact with her was lost. It was afterwards discovered that she had a supravaginal hysterectomy performed one year later because of vaginal bleeding. The cervix was reported as normal in appearance at that time. She died one year later with generalized abdominal metastases.

COMMENT

It must be remembered that the class of patients reporting to the Oncologic Hospital are made up of individuals who, as a rule, give little attention to medical care.

CONCLUSIONS

Although the number of cases studied was small and some of them have been followed for less than five years, it is believed that:

(a) The use of lead shields, separated by gauze, to protect the bladder and rectum during radium treatment is a successful means of preventing the formation of rectovaginal and vesicovaginal fistulae.

(b) The radium bomb is a valuable adjunct to the therapy of carcinoma of the cervix in that it may be used to prolong life after intracavitary radium or 200 kv. roentgen therapy is considered to be of no value.

(c) More care should be exercised in the examination of patients prior to performing a supravaginal hysterectomy so that the percentage of carcinomas of the cervical stump may be reduced.

Acknowledgement is made to Miss Leah T. Cadbury who did the follow-up work on these cases.

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RADIATION OSTEITIS AND FRACTURES FOLLOWING IRRADIATION

WITH REPORT OF FIVE CASES OF FRACTURED CLAVICLE

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THE potential destructive capacity of roentgen and gamma radiation is well known to everyone with experience in this field of therapy. Irradiation in dosages sufficient to be therapeutically effective may produce in tissues permanent secondary changes that must be foreseen and considered. The visible surface effects have quite naturally received the most attention, but there has accumulated a large number of reports on the effects on the deeper tissues. These secondary effects of radiation are being increasingly discussed, and the coincidental changes in organs such as the bladder, lung, and intestine are well recognized. The effect of radiation on bone has received comparatively little attention, but the late changes in the skeletal system have considerable clinical interest and importance.

Most of the important sequelae of irradiation are localized and specific results due to anatomical location, as for example, the bladder ulcers that may follow radium treatment of cancer of the cervix, or pulmonary fibrosis incident to postoperative irradiation of breast cancer. The question of the effect on bone, however, has a more universal application because few areas of the human body can be irradiated without bone tissue being traversed by the beam of rays. In most instances, of course, the unavoidable irradiation of bone is of no practical significance, but there are a few situations in which it would appear to be important. It is the purpose of this paper to review the effect of irradiation on bone and to illustrate it by clinical observations.

PHYSICAL FACTORS INVOLVED IN REACTION OF BONE TO IRRADIATION

Osseous tissue does not tolerate radiation as well as most tissues because of its physical and structural differences. This has not been more apparent clinically because, except in the case of crossfire, bone receives a smaller tissue dose than the intervening tissues, and because the effects of aseptic necrosis may be innocuous except at critical weight bearing points. Because of its physical properties, bone absorbs much more energy per unit of volume than any other tissue, a fact which is apparent at a glance at any roentgenogram if one notes the differential densities of bone and soft tissues. According to Failla,[5] this increase in absorption may amount to as much as 30 to 40 per cent in some instances. Another important factor in the reaction of bone is the greatly increased secondary radiation produced by the high calcium content. This increase in secondary radiation causes greater damage to the blood vessels, the periosteum and the endosteal cells than would occur if they were entirely surrounded by soft tissues.

In determining the effect of irradiation on bone there are several variables that must be considered. The dosage of radiation is obviously the most important of these, and this factor is itself influenced by two other variables, namely, the depth of the bone under the skin surface, and the quality of the radiation. In addition to its effect on the degree of absorption by intervening tissues, the quality of the radiation is a separate consideration in itself, as rays of shorter wave length will produce less secondary radiation and will be less absorbed themselves than will softer rays in a given thickness of tissue. Another important variable is the manner in which the radiation is administered, that is, by massive dose technique or fractionated in small doses. Still another variable is the anatomical peculiarity of the blood supply of any given bone. Thus, while a phalanx or a clavicle

will receive more radiation through the overlying tissues than will a femoral neck, the femoral neck and head constitute one of the most vulnerable anatomical units in the skeleton from the standpoint of vascular supply.

PATHOLOGY OF RADIATION REACTION IN BONE

There is a distinct delay in the reparative reaction of bone tissue when it is injured, and this is especially true of radiation reaction. The obliterative endarteritis that occurs in any tissue if it is irradiated heavily enough adds to this delay in repair, and, as in any other tissue this effect may be progressive, with gradual vascular occlusion occurring over a period of years. This damage to the blood supply will in itself inhibit repair, and the slow progression of such a process may produce aseptic necrosis years after the original radiation injury.

Stages of Bone Reaction. When an attempt is made to classify the pathological changes in bone due to irradiation, it must be realized that the extent of the change is dependent on the amount of radiation received by the bone. The reaction is entirely one of degree, and may end anywhere between the extremes of complete recovery or necrobiosis. Ewing[4] in 1926 described five stages of radiation effect on bone, but did not indicate the dosage required for their production. According to his definition, the first stage, following only light irradiation, is a decrease in the vitality of the bone cells with a temporary cessation of the growth capacity, followed by full recovery. With heavier irradiation a productive osteitis occurs with thickening of the bone outline and "fuzziness" of the periosteum. This does not recover fully but some permanent damage remains. With still heavier irradiation a sclerosis of the bone takes place, but fragility follows and fractures may occur even though the bone is more dense. Radiation given to the limit of therapeutic use may produce aseptic necrosis and sequestration. There is practically no recovery in this stage, and absorption of the dead bone may require years, or may not take place at all. A fifth stage of radiation effect on bone is the result of infection superimposed on osteoradionecrosis. This is seen principally in the mandible and bones of the face in patients being treated for intraoral cancer.

Structural Alteration and Problem of Repair. It is evident that there is no single typical microscopic picture of radiation osteitis. Early effects may consist only in periosteal thickening with fibrosis and hyalinization, and early fat replacement and fibrosis of the marrow. There may be osteoporosis with slight change in the architectural pattern of the lamellae and cancellous portions. As the reaction becomes more advanced there is sclerosis and obliteration of the blood vessels, complete fat replacement of the marrow, and absorption of the bone with osteoid tissue filling in, or complete lack of attempt at new bone formation. Ewing emphasized that in the later stages there is fibrosis and loosening of the periosteum and absence of endosteal osteoblasts. With further change there is more or less aseptic necrosis with sequestration. Microscopically there are fragments of necrotic bone surrounded with foreign body reaction and osteoclasts. The necrobiosis and sequestration may be fragmentary or massive. As seen clinically at this stage, there is little or no repair, and sequestra may remain unaltered for years. The problem of repair here is different than in aseptic necrosis from other causes. In a recent article Phemister[14] has discussed in detail the subject of aseptic necrosis of bone from causes other than irradiation. He describes the process of repair as one of "creeping substitution" by fibrous tissue from the periphery, with absorption of the dead bone and gradual replacement by new bone. This mechanism cannot function as efficiently in necrosis from irradiation because the reparative elements of the bone have been destroyed over a wide area. The blood supply is undergoing progressive reduction, and the entire block of tissue about the bone has been altered by the irradiation.

CLINICAL CONSIDERATIONS

In certain clinical situations radiation to bone may produce complications that must be considered in planning the treatment. In general, these conditions can be resolved into four types: (1) where treatment is given over a growing bone, particularly over the epiphysis; (2) where the bone is liable to infection, as in the mandible, or in the skull when a deeply ulcerating tumor of the scalp is being treated; (3) where the bone is close to the surface, as in the phalanges, metacarpals, skull, or clavicles; (4) where weight bearing is necessary and the blood supply is not guarded by an extra margin of safety, as in the femoral neck. Fractures may occur in weight bearing bones, paricularly in the femur and femoral neck, and may also occur in non-weight bearing bones, even when they are not subjected to unusual stress and strain. The occurrence of fractures is one of the limiting factors in attempting to cure osteogenic sarcoma by irradiation, as the bone may be left in such a condition that amputation of the extremity is necessary, even though the tumor itself has been sterilized.

Effect of Radiation on Growing Bones. One of the most important functional effects of radiation on bone is interference with growth capacity. This has been known and proved experimentally for many years, Cluzet[2] being the first to show this effect, and it has been demonstrated many times clinically. It is well known that irradiation over the epiphyses of growing bones in children may produce serious growth arrests, and it is a clinical rule that radiation should not be directed over such an area except for imperative clinical indications. A good example of this is a case reported by Stevens,[18] in which irradiation over the left pelvis and upper femur for a malignant soft part tumor in a four months old infant produced marked shortening and distortion of the entire extremity and pelvis on the irradiated side. Four years later there was obvious shortening and osteoporosis, and acute suppurative osteomyelitis had supervened in the femoral shaft. Another example is a child treated at Memorial Hospital for a malignant tumor of the tongue. This child was treated at the age of eight weeks with external irradiation, receiving 1,800 r* through the right submaxillary region and 2,100 r through the left cheek, using 6.75 sq. cm. fields, at 198 kv., 63 cm. target-skin distance, with 0.5 mm. Cu filter. The tongue lesion was cured, but the mandible failed to develop (Fig. 1), and the child has practically no teeth now at the age of eight years. These 2 cases represent serious but unavoidable secondary effects of life-saving measures. They serve to emphasize that radiation therapy should not be used over growing bones for benign conditions except under extraordinary circumstances.

Fig. 1. Photograph of boy treated in infancy for sarcoma of the tongue, showing lack of mandibular development.

Infection in Irradiated Bone. Probably the most frequent serious bone lesion following irradiation is radionecrosis and osteomyelitis of the mandible. This complication in the treatment of intraoral carcinoma is a recognized hazard and constitutes a

* Unless otherwise stated, all doses are given as roentgens in air.

Fig. 2. Acetabular fracture in patient treated for carcinoma of the cervix.

definite factor in the mortality in patients with such lesions. It must be emphasized, as Martin and his associates[7,8,9,10] have pointed out repeatedly, that two distinct factors are responsible for the occurrence of osteomyelitis of the mandible in irradiated cases. First is the radiation itself which produces necrobiosis of the bone when given in cancer lethal doses. This stage of necrosis is sterile, and the bone may remain indefinitely as a functional unit just as a piece of boiled bone or a metal plate. The second factor is the introduction of infection, and this may produce an almost explosive osteomyelitis with extensive involvement. This usually occurs by sloughing of overlying tissues, or when a tooth is pulled and the open socket is unavoidably exposed to mouth organisms. Martin has been able to cut down the incidence of this complication in his clinic by avoidance of external portals and the use of intraoral cylinders, by using portals as small as possible, and by dental care or extraction of teeth before treatment is started. Watson and Scarborough[19] have published a review of this subject, in which they found osteomyelitis of the mandible to occur in 20 per cent of cases treated at Memorial Hospital between the years 1930 and 1937.

Fractures of the Femur. Fractures occurring in weight bearing bones that have been irradiated have been recognized for many years. Ewing has reported a case and mentioned others that occurred in patients treated for osteogenic sarcoma of the femur, in which there was a fracture through the portion of bone that was irradiated, but which was not involved by tumor. More recently there have been several reports of fracture of a femoral neck in patients treated by roentgen irradiation for malignant tumors of the pelvis. There are in the literature detailed reports of 24 such cases (Baensch;[1] Philipp;[15] Kropp;[6] Dalby, Jacox and Miller;[3] Okrainetz and Biller[12]). The largest series was given in detail by Dalby, Jacox and Miller who reported 14 cases of spontaneous fracture of a femoral neck in 471 patients treated by irradiation for malignant tumors in the pelvis, an incidence of 2.1 per cent. More recently Miller and Folsome[11] from the same hospital have mentioned that they found 35 patients with femoral neck fractures in the series of patients treated there for cancer of the cervix. These last cases were not reported in detail, nor was it stated whether or not they included the original 14. In none of these reported cases was there any evidence of metastasis at or near the site of fracture in the involved bone. At Memorial Hospital there are 13 patients with fractures of the femur who have been treated over the pelvis with external irradiation. Twelve of these cases are from the Gynecology Service and one is from the Rectal Service. The average age of these patients was fifty-seven. The 12 cases were all treated for cervical cancer, and of these, only 6 can be shown to be spontaneous fractures, the others having either a history of trauma, or being doubtful as to causation. It is interesting to note that 4 of the 6 patients with

spontaneous fractures had massive dose therapy consisting of 750 r at a dose to each of six pelvic portals. This was given at 200 kv., 70 cm. target-skin distance, 0.5 mm. Cu filter, and an average field of 14 by 11 cm. This dosage was repeated once in most cases, giving a total of 1,500 r per portal. One case had the cycle repeated three times on the left side, and the left hip joint has suffered two fractures and almost complete obliteration of the joint (Fig. 2 and 3). In one case from the Rectal Service the fracture was also spontaneous. This patient received three pelvic cycles to six portals, 450 r being given at a time through each portal with the same factors as outlined above. These spontaneous fractures all have a common type of onset. They usually occur about three years after the irradiation, and the patients complain of pain for some months before the fracture is evident. Then either an acute shearing process occurs while the patient is walking, or shortening is noted accidentally and a roentgenogram reveals a fracture that was present for some time but was unsuspected. These fractures do not heal well and many remain ununited, either with sequestration or complete absorption of the femoral head. It is worth noting here that in one case the fragments were nailed and a good functional result was obtained, the patient walking for eighteen months up to the time of death. Serial roentgenograms of the hip joint during this time showed no reaction about the fracture fragments whatsoever, either of proliferation or of absorption of bone about the nail. An attempt has been made to estimate the tissue dose of radiation received by the femoral necks that fractured, and the range is from approximately 3,000 to 6,000 r. The high figure is a single case and represents unusually high dosage. The other cases were all within the limits of radiation dosage ordinarily employed.

Irradiation over Superficial Bones. Irradiation over bones that are superficial and close to the surface is a hazardous procedure and may produce painful and serious changes in the bone. The danger of directing radiation over the fingers and toes is well recognized, and in addition the metacarpals and other superficial bones are affected. Changes in the ribs underlying irradiated areas are fairly common, but do not ordinarily produce serious consequences. The skull is another site in which bone changes are not infrequent. The changes in the skull are not usually noted unless ulceration of the overlying tissues occurs, with infection and osteomyelitis. Two case reports are included as examples of the effect of radiation on the phalanges and metacarpals.

Fig. 3. End-result of same hip joint shown in Figure 2, showing second fracture through the femoral neck.

L. S., white female, aged twenty-three, was referred to Memorial Hospital for treatment of a synovioma of the tendon sheath on the dorsum of the distal end of the fourth metacarpal. This tumor was 3 by 2 by 2 cm. in size, and had been excised elsewhere, but had recurred before the wound healed. Treatment given here was as follows: 250 r was given on alternate days through a 5 cm. circular portal to the anterior

Fig. 4. Bilateral fracture of femoral necks in patient irradiated for carcinoma of the cervix.

and posterior aspects of the hand for a total of 4,000 r to each portal, at 174 kv., 63 cm. target-skin distance, and 0.5 mm. Cu filter. There was complete regression of the tumor and the patient was well for two years. Then pain and swelling recurred in the irradiated area (Fig. 5). There was no ulceration, and amputation through the third and fourth metacarpals was done for what was thought to be recurrence. The surgical specimen, however, showed only radiation osteitis and fracture of the phalanx. There was no recurrence and the patient has been well now for seven years.

R.C., white male, aged sixteen, was under treatment at Memorial Hospital for a lymphangioma involving the entire left upper extremity. On February 10, 1936, eight steel needles containing radon were inserted into a portion of the tumor over the dorsum of the hand, giving a total dose of 4,655 mc-hr. Two years later an ulcer formed in this area, which progressed until the underlying metacarpal was exposed. A low grade osteomyelitis developed in this bone and remained confined to it, but a roentgenogram of the hand shows radiation changes for a wide area about this bone (Fig. 6). This ulcer is not completely healed to date.

Fig. 5. L.S. Fracture of fourth phalanx in patient treated for synovioma overlying this area.

Effect of Gamma Radiation on Bone. This second case also serves to illustrate the danger of placing radium or radon near bone. Although experimentally, bone is less affected by gamma rays than by softer roentgen rays for a given dose of radiation,

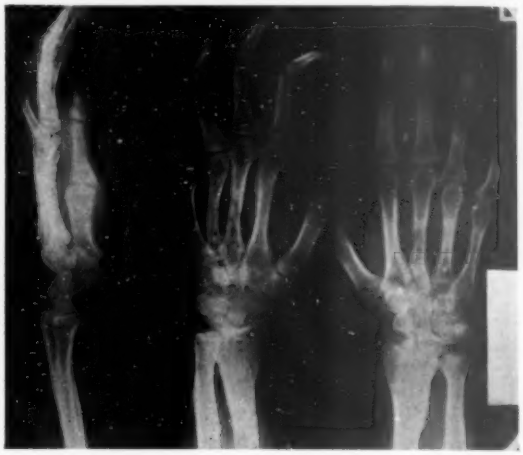

Fig. 6. R.C. Effect of radium needles in soft tissues overlying the metacarpals and carpus.

clinically it is a rule that radium or radon cannot be placed close to or in contact with bone without painful sequelae or destruction. Phemister[13] in 1926 showed that aseptic necrosis of bone could be produced regularly by seemingly small doses of radium in contact with the cortex of the femurs in rabbits and dogs, and he produced necrosis with doses in the range of 250 mg-hr. from platinum needles. Analysis of this situation reveals that the dose from such a needle when transposed to roentgens may be very high at distances of 1 to 2 mm. According to Sievert[17] the intensity of radiation from a 1 cm. tube of 0.5 mm. platinum at 1 cm. distance is 7.2 r/mg-hr.

At 1 mm. distance the intensity is 30 times this figure and at 2 mm. it is 13 times as high. From these figures, it is easy to see why bone necrosis can be produced by radium needles in contact with bone.

Fractures of the Clavicle. The clavicle may also be affected, and there are 5 patients with fracture of the clavicle and 3 with fracture of ribs, occurring in irradiated areas in patients treated at Memorial Hospital for cancer of the breast. All these fractures occurred during the course of the patient's normal activity, and there is no evidence of metastatic carcinoma in any of the bones involved. Two of these patients with fractured clavicle had fractures of underlying ribs in addition. Only 3 of the 8 patients had any knowledge of the injury to the bone; the others were discovered by roentgen examination in the course of our routine follow-up. Of the 3 patients with acute fractures, one occurred while the patient was opening a window, one when the patient turned over in bed on to the affected side, and the third when the patient slipped while walking and righted herself by catching a nearby bed-post with the involved arm. The roentgenogram of this last patient, taken at the time of the injury, showed fracture of the clavicle, the second, third and fourth ribs, and absence or absorption of the anterior portion of the third rib. The 3 patients in whom fracture was found accidentally showed marked skin change over the irradiated area, from radiation treatment given years before (Fig. 7). Except for one autopsied case dying of distant metastases, none of the other 7 cases show any evidence of disease at present. Five of them have been followed for six years but the other 2 were treated only two years ago. One of the patients in whom evidence of an old unsuspected fracture was discovered by chance has, within the last month, had a second fracture through the same clavicle when she slipped on a stairway and steadied herself by a quick grasp of the railing. It is probable that many more patients have had fractures of the clavicle than have been discovered, but this cannot be demonstrated unless a definite effort is made to find them.

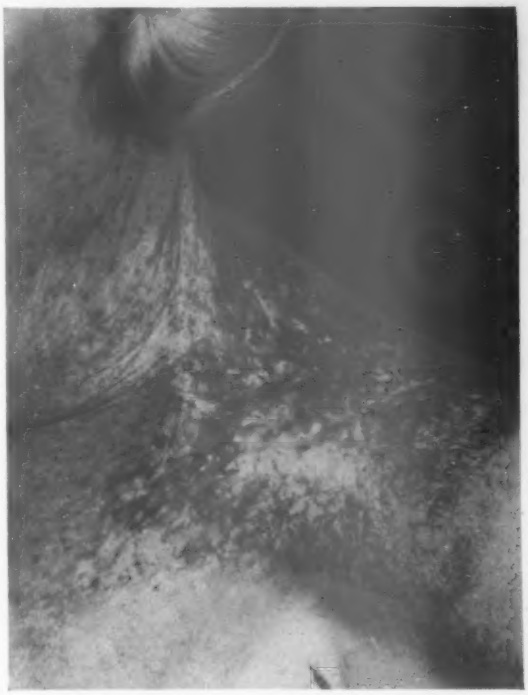

Fig. 7. Ulceration of skin occurring sixteen years after irradiation for cancer of the breast.

An attempt has been made to determine the tissue dose of roentgen radiation delivered to the clavicles and ribs in these cases. In only 4 of them are the factors sufficiently complete to afford a relatively accurate estimate. In the other 4 cases, which were all treated between the years 1924 to 1933, the analysis of the depth dose is only an approximation which must be considered to have a rather wide range of error. In these doubtful cases, the size of the fields and their exact anatomical limits are not known, and in 3 of the cases the kilovoltage of the machines and the dose in roentgens are estimates made from historical knowledge of machines in use before 1930. By these estimates, the range of tissue doses delivered to the clavicle or ribs is from 1,500 to 4,000 r. Five of the cases had gamma radiation in addition, which is listed below. Case III had the lowest total dose in roentgens, without gamma radiation in addition; yet she was one of the

Fig. 8. Case I. Unhealed fracture of the clavicle seven months after injury.

cases with the most severe after-effects. Short summaries of the treatment of these 8 cases are listed below.

CASE REPORTS

Case I. M. R., white female, aged forty-four, admitted to Memorial Hospital on March 10, 1939, for treatment of a carcinoma of the right breast. A radical mastectomy was performed on March 13, and the patient was given postoperative irradiation, receiving 1,800 r to each of two portals, anterior and posterior supraclavicular, measuring 12 by 20 cm. She received 300 r daily to each field, at 250 kv., 50 cm. target-skin distance, with 1.5 mm. Cu filter, the last treatment being given on July 7, 1939. On September 5, 1940, she turned over in bed on to the right side and suffered a fracture of the right clavicle which has not healed to date (Fig. 8), (March, 1941). There is evidence of slight callus formation. The tissue dose delivered to the clavicle has been estimated at 1,960 r through the anterior portal and 700 r through the posterior, a total of approximately 2,660 r.

Case II. E. S., white female, aged seventy-nine, was given preoperative irradiation for carcinoma of the right breast, receiving 2,100 r to each of six portals, 300 r every third day, at 200 kv., 0.5 mm. Cu filter, 50 cm. target-skin distance, and with fields of 13 by 13 cm. in size. On June 26, 1939, a simple mastectomy was done, and patient has shown no evidence of disease since. On November 18, 1940, patient was raising a window and her right clavicle fractured. No healing has taken place as yet. Analysis of the depth dose to this clavicle reveals that it received approximately 2,290 r through the anterior portal and 820 r through a posterior portal, an approximate total of 3,100 r.

Case III. L. D., white female, aged forty-nine, admitted to Memorial Hospital on February 21, 1933, for postoperative irradiation after a left radical mastectomy done elsewhere one month before. The following radiation treatment was given:

2-27-33 left breast, upper half, 600 r, 140 kv., 4 mm. Al, 30 cm. T.S.D.
3-1-33 left breast, lateral, 600 r, 140 kv., 4 mm. Al, 30 cm. T.S.D.
3-3-33 left breast, lower half, 800 r, 200 kv., 0.5 mm. Cu, 40 cm. T.S.D.
3-6-33 left breast, axilla, 750 r, 200 kv., 0.5 mm. Cu, 50 cm. T.S.D.
2-13-34 left breast, lower half, 600 r, 200 kv., 0.5 mm. Cu, 50 cm. T.S.D.
2-14-34 left breast, lateral, 600 r, 140 kv., 4 mm. Al, 30 cm. T.S.D.
2-16-34 left breast, upper half, 750 r, 200 kv., 0.5 mm. Cu, 50 cm. T.S.D.
2-19-34 left breast, axilla, 750 r, 200 kv., 0.5 mm. Cu, 50 cm. T.S.D.

Fig. 9. Case III. Old fracture of the clavicle with pseudoarthrosis two years after injury and seven years after irradiation.

In December, 1939, patient stumbled and in catching herself felt a sharp pain in her shoulder. A roentgenogram at that time showed a fracture of the left clavicle and several ribs, with absence of the anterior portion of the third rib. Roentgenograms at the present time show a healed fracture of the fourth rib, but a pseudarthrosis of the clavicle with sequestra. According to calculations this patient received approximately 1,500 r to the clavicle (Fig. 9).

Case iv. M. H., white female, aged fifty-six, admitted to Memorial Hospital on January 8, 1924, for postoperative irradiation following radical mastectomy done elsewhere in 1923. The following radiation treatment was given:

1-14-24 2 T.E.D. left upper breast, 120–140 kv., 4 mm. Al, 30 cm.
1-18-24 2 T.E.D left axilla, 120–140 kv., 4 mm. Al, 30 cm.
6-3-24 10,000 mc-hr. with radon pack at 6 cm. with 2 mm. brass filter to left supraclavicular region
5-5-26 2 T.E.D. left upper breast, same factors as above
5-8-26 2 T.E.D. left supraclavicular portal, same factors as above

Skin ulceration in the supraclavicular region occurred in May, 1940, and has been progressive. A roentgenogram of the clavicle taken at this time showed a deformity in the middle third suggestive of pseudarthrosis. It is estimated that this patient received a tissue dose in the clavicle of 2,400 r.

Case v. A. B., white female, aged sixty, admitted to Memorial Hospital on June 6, 1928, for treatment of a carcinoma of the left breast. Treatment administered was as follows:

7-7-28 500 r to upper half of breast, 185 kv., 30 cm. T.S.D., 0.5 mm. Cu
7-11-28 500 r to left axilla, same factors
8-1-28 Left radical mastectomy
10-26-28 500 r to upper half of breast area, same factors as above
10-30-28 500 r to left axilla, same factors as above
4-17-29 500 r to left supraclavicular area, same factors as above
4-20-29 500 r to left axilla, same factors as above
3-5-30 8000 mc-hr. to supraclavicular region, with radon pack at 6 cm. distance and 2 mm. brass filter
3-7-30 8000 mc-hr. to same area with same factors

The dosage in roentgens given above is an approximation from estimates of the factors given at the time. There is now a marked skin reaction, and a roentgenogram of this area reveals an unhealed fracture of the second rib which has not changed in eight months.

Case vi. H. K., white female, aged twenty-six, admitted to Memorial Hospital in July, 1935, for treatment of a carcinoma of the breast with axillary metastases. From July 15 to July 26, 1935, she was given treatment with the radium element pack, receiving 24,000 mg-hr. each to the right breast, to an anterior axillary portal and to a posterior axillary portal, and 20,000 mg-hr. directly to the axilla. These treatments were given at 6 cm. distance with a filter of 0.35 mm. platinum and 1.5 mm. brass. On August 2, 1935, an axillary tandem was inserted for a dosage of 2,000 mc-hr. From April 17 to May 4, 1936, patient was given roentgen therapy to 3 portals, anterior and posterior axilla and supraclavicular regions, and directly to the axilla. The radiation was given at a dose of 300 r to each portal, for a total of 1,800 r, at 198 kv., 50 cm. target-skin distance with a filter of 0.5 mm. Cu. A roentgenogram of the chest on July 7, 1936, showed on the affected side radiation changes in the clavicle with dislocation at the sternoclavicular joint, absence of the anterolateral and anterior portions of the upper three ribs and fracture of the fourth. Patient went rapidly downhill from distant metastases and died on July 13, 1936. Autopsy confirmed the findings of radiation change in the clavicle and ribs. This patient received approximately 2,200 r tissue dose to the clavicle and ribs from the roentgen treatments alone.

Case vii. E. H., white female, aged twenty-nine, admitted to Memorial Hospital on November 12, 1924, for treatment for a carcinoma of the right breast. Radiation treatment administered was as follows:

11-19-24 2 T.E.D to right upper breast, 120–140 kv., 4 mm. Al, 30 cm.
1-3-25 Simple mastectomy and axillary dissection, followed by implantation of 14 bare radon tubes into the axilla and pectoralis muscles for a total dose of 1222 mc-hr.
2-10-25 2 T.E.D. to right upper breast, same factors as above
5-13-25 2 T.E.D to right upper breast, same factors as above
10-9-25 2 T.E.D. to right upper breast, same factors as above
11-18-26 2 T.E.D. to right upper breast, same factors as above
3-6-27 11,000 mc-hr. to the supraclavicular area with the radon pack at 6 cm. distance and 2 mm. brass filter

In 1936 a roentgenogram of the shoulder girdle on the right showed a deformity of the clavicle and fractures of the second and third ribs with areas of calcification suggestive of sequestra. This patient has recently had a second fracture through the same clavicle. She received approximately 4,000 r to the upper breast.

Case VIII. A. M., aged forty-eight, admitted to Memorial Hospital on June 8, 1935, for treatment of a cancer of the left breast. She was given preoperative irradiation from June 11 to July 1, 1935, consisting of 1,800 r to each of five portals in doses of 300 r per portal at 198 kv., 50 cm. target-skin distance and 0.5 mm. Cu filter with fields averaging from 150 to 200 sq. cm. On July 24, 1935, an axillary tandem was inserted for a total dose of 2,000 mc-hr. On September 11, 1935, a left radical mastectomy was done. In the following years the patient had been bothered by radiation fibrosis of the lung, and serial roentgenograms of the chest show progressive damage to the upper ribs. Absorption of the anterior portion of the second rib was first noted in 1937, and a recent roentgenogram shows changes in the upper three ribs, with absence of anterior portions of the second and third and a spontaneous fracture at the angle of the fourth. Patient has been free of any evidence of carcinoma since 1935. It is estimated that this patient received 2,200 r tissue dose to the upper ribs.

SUMMARY AND CONCLUSIONS

The effect of radiation on bone deserves more consideration than it is usually accorded. Bone is one of the more radiosensitive tissues in the body, and may be profoundly changed by irradiation in certain clinical situations. Because of its high calcium content bone absorbs much more energy from radiation per unit of volume than any other tissue, and for the same reason the secondary radiation is more intense. This combination of factors produces more cellular damage than would occur in a similar volume of soft tissue with a given amount of radiation. The blood supply to bone is also a relatively fixed system compared to that of most soft tissues, and does not allow flexibility in the development of collaterals. The effect of radiation on bone is further influenced by the dosage of radiation, and by the size of the portal used, the depth dose being larger with increasing area of portal. The distance of the bone from the skin surface is an obvious variable, and so also is the quality of the radiation, there being less energy absorption and less secondary radiation from rays of shorter wave length. The manner in which the radiation is administered is an additional variable, as massive doses will cause more damage to bone than will fractionated irradiation in the same total dose.

The pathological picture of radiation effect on bone is entirely one of degree, and depends on the amount of radiation absorbed by the bone. From light doses almost full recovery may take place, and with heavier dosage the damage increases until the bone undergoes necrobiosis. In this stage there is not only complete lack of repair, but the dead bone may remain indefinitely as a sterile foreign body. Fragility of the bone occurs before this stage, however, and fractures may happen without roentgen evidence of change. Repair of radiation damage to bone is slow and incomplete, and changes may be progressively worse over a period of years as the blood supply is decreased by endarteritis.

The clinical importance of radiation effect on bone has been discussed under four headings: the effect on growing bones, the danger of infection in irradiated bone, the effect on bones close to the skin surface, and the problem of fractures in weight bearing bones. It has been emphasized that irradiation over growing bones is extremely dangerous, as it may stop growth entirely, especially if given over an ununited epiphysis. This should never be done if there is any other possible way to treat the patient. The problem of infection in irradiated bone is encountered most often in cases of head and neck cancer where the mandible is in the beam of radiation. The mandible is particularly vulnerable because its blood supply is a central artery encased in bone which allows no room for expansion in inflammation and edema. It is close both to the skin and mucosal surfaces and is subject to the large doses given for intraoral

cancer. Infection occurs in the mandible by sloughing of overlying tissues exposing a bone devitalized by radiation, or by pulling of a tooth after treatment thus allowing ingress of virulent mouth organisms. The mandible may remain as a necrobiotic functional unit for years without trouble, but if it is exposed to infection a severe osteomyelitis will develop which carries a definite mortality percentage. This complication may be reduced in incidence by avoidance of external portals, by using intraoral cylinders, and by using a portal as small as possible. Dental care before treatment is started is mandatory, and it is wise to have extractions of infected teeth if they will be in the direct beam of radiation.

The danger of irradiation over superficial bones such as the phalanges is well recognized, but other superficial bones are similarly vulnerable. The clavicle, ribs, and skull may all be severely damaged by radiation, and in the case of the clavicle and ribs it is recommended that portals be made as small as possible. The use of smaller portals will require accurate localization of the area to be irradiated and painstaking direction of the beam, which are certainly worth while objectives in themselves, apart from other considerations. In treating scalp tumors it is probably better to use surgical measures and primary skin grafting for large tumors rather than subject the underlying skull to irradiation through large portals with consequent sloughing and possible exposure of the bone to infection.

The possibility of fracture in weight bearing bones is well known and is particularly applicable to the femur. Aseptic necrosis and fracture are two of the factors limiting the radiation treatment of osteogenic sarcoma. Fracture of the femoral neck occurs in a small percentage of cases irradiated for malignant tumors of the pelvis. The incidence is probably too small to be significant, but fractures here could be eliminated by shielding the area of the femoral neck, as radiation directed to this area can serve no useful purpose when the treatment is given for cancer of the cervix or other malignant tumors of the pelvis. It is believed that lateral portals are to be condemned for this reason.

In the cases with fracture of the femur, clavicle, or ribs reported here, the tissue dose in the bones involved varies from 1,500 to 6,000 r, the clavicles and ribs averaging approximately 2,000 r, and the femoral neck 3,000 r. When this range of dosage produces such effects, it is understandable why radium or radon in contact with bone is so damaging. If the dose from needles or seeds is transposed to roentgens, it is found to be much higher than this at distances of 1 to 2 millimeters. This dosage in roentgens from radium or radon at contact distance may be enormous, and is an adequate explanation of the clinical rule that radium or radon should never be placed close to bone when used in interstitial irradiation.

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RADIUM IN THE TREATMENT OF HONGKONG FOOT

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I FIRST became acquainted with Hongkong foot when sent to Shanghai as director of the Sino-Belgian Radium Institute. I saw many cases which had been treated for several years with solutions and ointments of a great variety. Many obtain only a temporary disappearance of their ailment.

Hongkong foot is a very common disease in the Far East, attacking any person exposed under favorable circumstances, regardless of sex or age. It appears on one foot and gradually spreads to the other, also to the hands and the face. It is very contagious and often an acute infection makes the patient unable to work for several weeks.

The etiology is not yet well established, but it behaves like an infecting organism.

The workers on this subject are very numerous, but I will refer to Dr. F. Reiss who is an authority on fungus diseases in China. He has isolated from Hongkong foot the following species: (a) *Epidermophyton rubrum;* (b) *Epidermophyton inguinale;* (c) *Trichophyton interdigitale;* (d) *Trichophyton pedis;* (e) a few other species which have not yet been determined.

As we gathered the impression that the condition was an infection, we treated a few cases with radium, filtered through 0.2 mm. platinum. To our great satisfaction, pain and itching disappeared a few days after treatment and one patient was completely cured.

We then treated another series of patients with 2 mg. tubes of radium filtered through 1 mm. platinum, applied with plaster on the skin at 1 cm. distance, for forty-eight hours.

We deliver a large enough dose to produce a desquamation of the skin after fifteen to twenty days, with healing complete within a month. A precaution upon which success depends is the disinfection of the socks by boiling and the shoes by formalin powder. If the patient can afford it we advise him to wear new shoes.

We treated by this method 82 patients, all suffering from the disease for several years.

Among them 80 were cured after one single treatment and have remained so, though a long period has elapsed. Twenty-five cases have been followed for five years; 30 cases have been followed for four years; 20 cases have been followed for three years, and 7 cases have been followed for two years. Among the last 7 cases, 2 were not cured completely when I saw them three to four months later; a few spots were still present and I advised a second treatment. One of them took the second treatment and was cured. The other could not take the second treatment because he was very busy travelling and the condition did not bother him much. I might add that these last two patients were travelling all the time in the interior of China and might conceivably have had a reinfection.

CONCLUSION

It is well proved on a fairly large number of patients and over a long period of observation that radium is very effective in treating Hongkong foot.

IS THE ACTION OF ROENTGEN RAYS DIRECT OR INDIRECT?

AN INVESTIGATION OF THIS QUESTION BY THE METHOD OF HUMAN MARROW CULTURE*†

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With the technical assistance of Evelyn A. Packham

MANY roentgen therapists have observed that irradiation of one area, particularly in leukemias, Hodgkin's disease, and lymphosarcoma, may be followed by diminution in size of lymph nodes or spleen in an area which was not irradiated. Some have postulated that this must be due to an indirect action of the roentgen rays, mediated either by some circulating substance or by the transportation through the blood stream of some emanation. A number of articles[1,2,3,4,6,7,9,10,11,21] have appeared giving evidence which the authors interpreted as supporting the view that the action of the irradiation was in part or in whole indirect. However, none of these investigators had available a method which permits as accurate a control as does the marrow culture technique. It seemed desirable, therefore, to reinvestigate the possibility of an indirect action of irradiation, using this technique which permits controlled quantitative studies of living human tissue. The present paper reports the results of these investigations.

In previous investigations,[16,17,19] using the same technique, it has been shown that the action of irradiation is to prevent the onset of mitotic and amitotic division, that the ratio of the effect on the highly susceptible lymphocytes to that on the less susceptible progranulocytes (promyelocytes) is the same with a small dose of 50 r as with a larger dose of 400 r. Increasing the dose from 50 r to 400 r increased the effect 1.7 times instead of 8.0 times. The effect on leukemic progranulocytes (promyelocytes) was similar to that on nonleukemic progranulocytes, although the rate of decrease was more rapid, which was interpreted as being due to a higher rate of cell division for the leukemic progranulocytes.

METHOD[20]

About 10 cc. of human marrow obtained by sternal puncture[13] was introduced into a 50 cc. vaccine vial containing 25 cc. of citrated balanced salt solution. After manipulations to eliminate most of the nonnucleated erythrocytes the final culture contained about 100,000,000 nucleated marrow cells suspended in about 50 cc. of medium consisting of 35 per cent human serum obtained from the fetal side of the placenta and 65 per cent balanced salt solution similar in composition to cerebrospinal fluid. This was thoroughly mixed. After removal of a sample for an initial total and differential cell count, equal volumes were transferred with syringe and needle to each of four 30 cc. vaccine vials. All of the transfers were made with syringe and needle through vaccine vial caps covered with 70 per cent alcohol. The four vials were then placed side by side in the compartments of the lead box previously described,[16,19] and two of the vials were given identical irradiation with the factors of 200 kilovolts, 7 milliamperes, 1 mm. of copper and 1 mm. of aluminum filtration at a 50 cm. distance, the radiation having a half-value layer of 1.52 mm. copper, with a total of 400 r given at the rate of 13.9 r per minute, as determined by H. D. Moreland using a Victoreen condenser type iometer with the chamber inside a similar vial from which the bottom had been removed. The other two vials were protected by the lead cover of the box, but were otherwise identical in composition and position. After irradiation

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the cultures were centrifuged, and the supernatant media from one of the irradiated and one of the non-irradiated cultures were removed and interchanged. There were then four cultures identical in every respect except that one received no irradiation, one in which both cells and medium were irradiated, one in which the cells alone were irradiated, and one in which the medium alone was irradiated. These were all placed in the incubator together, and at intervals samples were removed for total and differential cell counts. Total counts were made by the cerebrospinal fluid technique,[14] so that at least 400 cells were counted to give figures which were statistically more significant. Differential counts were made on Wright's stained smears[15] and enough cells were counted so that at least 20 of the least numerous cells were enumerated. From the total and differential counts the absolute numbers of each type of cell per cubic millimeter were calculated for each culture and each examination. The absolute number of a particular cell type in the experimental culture was calculated in percentage of the absolute number of the same type of cell in the control culture at the same time. The curves shown in the figures represent the weighted means of ten such experiments. These weighted means were calculated by adding the absolute number of each type of cell at each time period in the corresponding vials of each of the ten experiments and expressing the result in percentage of the sum of the absolute numbers of the same type of cell at the same time in the ten controls. The different cell types are pictured, and the criteria of classification and nomenclature are described in the Atlas of Hematology by Osgood and Ashworth.[18]

RESULTS

The results of these experiments are shown in Figures 1–4. In Figure 1, the weighted average for the different cell types in the ten irradiated cultures are compared with the ten controls. The control lines are all on the 100 per cent line for each type of cell, since the results were plotted in percentage of the absolute number of cells of the same type in the control. Note from curve 7 that the lymphocytes show an approximately straight line decrease from the time of irradiation and are the most susceptible cells. The progranulocytes (promyelocytes) in curve 6 are the next most susceptible cells, and also show an approximately straight line drop from the zero point which indicates the time of irradiation. The progressively more mature cells of the granulocyte series, which do not divide, show progressively decreasing rates of drop with increasing maturity and leave the control line at progressively

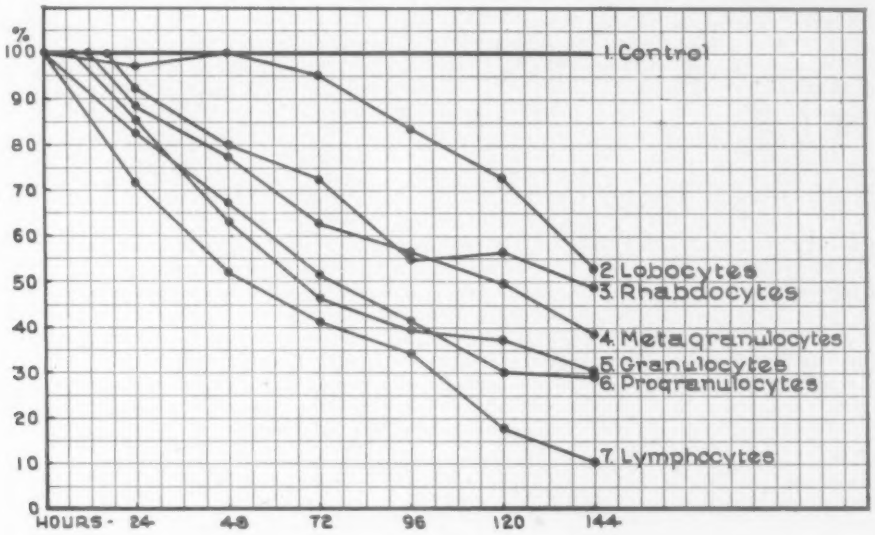

FIG. 1. Effects of irradiation with 400 r on the different cell types as compared with the control.

longer intervals after the time of irradiation, although only the curve for the lobocytes (polymorphonuclear neutrophils) follows the control for a period of time longer than twenty-four hours. The probable explanation for this, as previously shown,[16,18] is that the granulocytes (myelocytes) begin to decrease only after the progranulocytes would have matured to this stage, the metagranulocytes (metamyelocytes) only after the granulocytes would have matured to this stage, and so on for the rhabdocytes (staff cells) and lobocytes. It is noteworthy that the lobocytes do not begin to decrease until after about seventy-two hours, whereas their length of life is only about sixty hours,[12] so that the decrease could not have been due to the effects on the lobocytes present at the time that irradiation occurred.

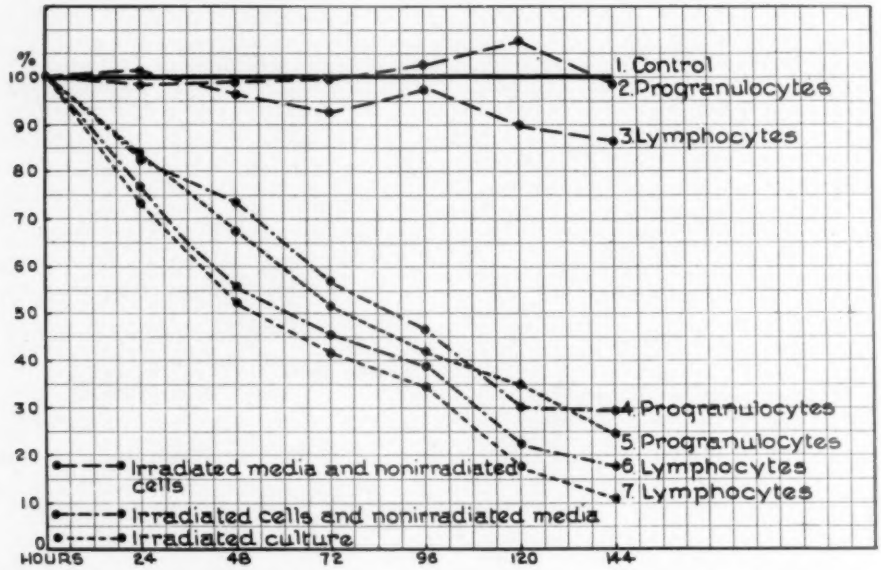

Fig. 2. Effects of interchange of media between irradiated and nonirradiated cultures on progranulocytes and lymphocytes.

In Figure 2 the effects of interchange of media between irradiated and nonirradiated cultures on progranulocytes and lymphocytes are shown. Note from curves 6 and 7 that there is no significant difference between the lymphocytes in the irradiated culture and the lymphocytes in the culture in which the cells were irradiated and the medium was not irradiated; whereas, in the corresponding cultures in which the cells were not irradiated and the medium was from an irradiated culture the effect on lymphocytes was not significantly different from the controls. Similarly, from curves 4 and 5 it is evident that the effects on the progranulocytes were similar in the irradiated cultures and the cultures in which the cells alone were irradiated; whereas, the curve (2) for progranulocytes in the cultures in which the cells were not irradiated but the medium was did not differ significantly from the controls.

Figure 3 shows the effect of interchange of media between irradiated and nonirradiated cultures on metagranulocytes (metamyelocytes) and granulocytes (myelocytes). Note from curves 6 and 7 that there is no significant difference between the irradiated culture and the culture containing only irradiated cells in the effect on the granulocytes, and from curve 2 that the granulocytes which received no irradiation but which were in a medium which was removed from an irradiated culture show no significant difference from the controls. Note from curves 4 and 5 in

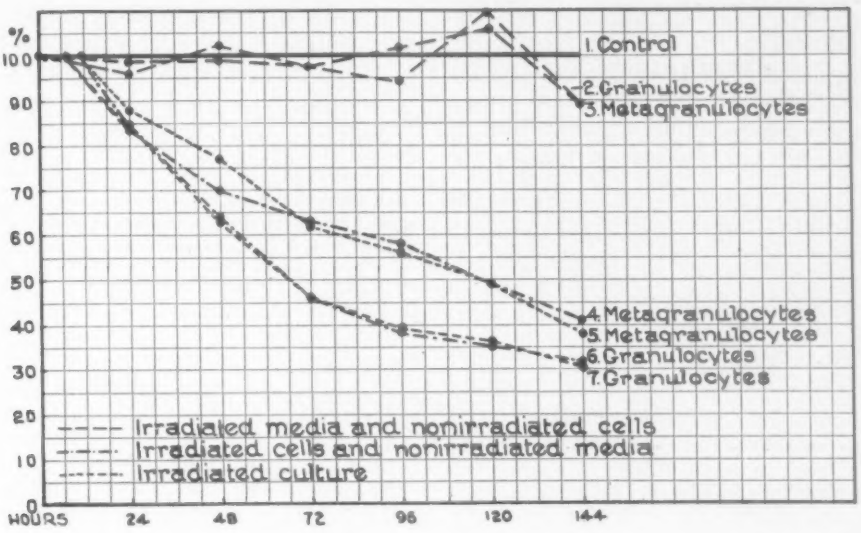

Fig. 3. Effects of interchange of media between irradiated and nonirradiated cultures on granulocytes and metagranulocytes.

Figure 3 that there was no significant difference between the effects on the metagranulocytes in irradiated cultures and in the cultures in which the cells alone were irradiated; whereas, from curve 3 the effect on metagranulocytes in the culture in which the cells were not irradiated but the medium was did not differ significantly from the control nonirradiated cultures.

Figure 4 shows the effect of interchange of media between irradiated and nonirradiated cultures on rhabdocytes (staff cells) and lobocytes (polymorphonuclear neutrophils). Note from curves 6 and 7 that there is no significant difference between the rhabdocyte curves in the irradiated cultures and in the cultures in which only the cells were irradiated, and from curve 2 that there was no significant deviation from the control in the rhabdocyte count in the culture in which the cells were not irradiated but the media was.

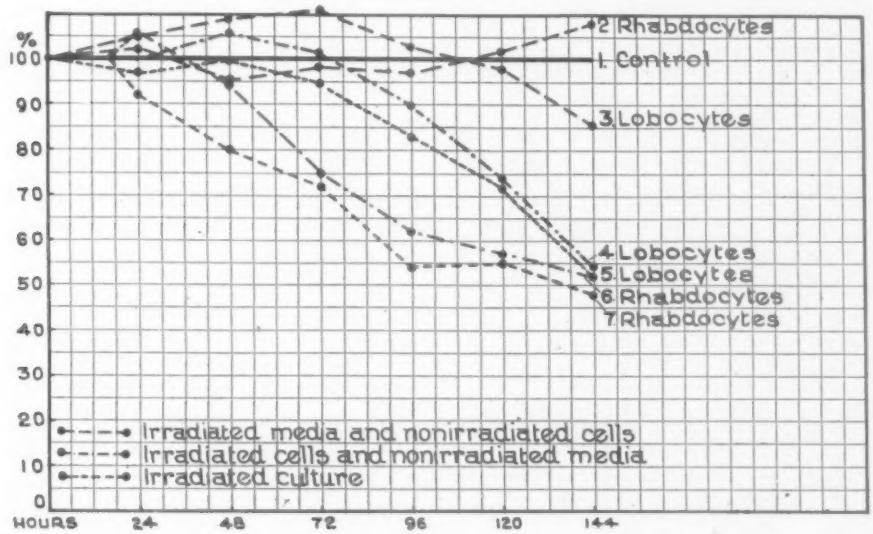

Fig. 4. Effects of interchange of media between irradiated and nonirradiated cultures on rhabdocytes (staff cells) and lobocytes (polymorphonuclear neutrophils).

Similarly, from curves 4 and 5 in Figure 4, note that the effect on lobocytes was the same in the irradiated culture and in that in which the cells were irradiated and not the medium; whereas, from curve 3 it is apparent that the lobocytes were not affected in the culture in which the cells received no irradiation and the medium has been irradiated.

COMMENT

These experiments lend further support to our previous evidence[16,17,19] that the effect of irradiation is in preventing the onset of amitotic division in the lymphocytes and mitotic division in the progranulocytes, and that the effect on the more mature cells of the granulocyte series which do not divide is due entirely to the effect in preventing division of the progranulocytes. Consequently, the effects do not become noticeable until enough time has elapsed for the progranulocytes, which would have been present had the division occurred normally, to mature to the corresponding stage of development. It is further apparent that under the conditions of these experiments there is no evidence of an indirect action of roentgen rays mediated through any leukocytotoxin or any emanation which could be transferred with the medium, and the effect must therefore be directly on the cells themselves.

If indirect action is excluded, what then is the explanation for the observed effects on bone marrow and lymph nodes outside of the zone of irradiation? It is noteworthy first that such distant changes have been observed exclusively in lymph nodes, spleen, and bone marrow, tissues from which the cells normally enter the blood stream, and that such changes have not been observed in fixed tissue. For example, the work of Jüngling[8] may be cited, in which a lead grid was placed over a carcinoma of the breast before heavy irradiation was administered, and irradiation effects occurred only in the areas not protected by the lead. Irradiation of a primary malignant tumor at one site does not influence the metastases which have already occurred. Why then should lymph nodes, spleen, and marrow be affected and not other tissues? The explanation that seems most plausible is that the cells of the lymph nodes, spleen, and marrow are not fixed tissue cells but are cells which constantly enter and leave the blood stream and migrate from place to place, and when any area in the body is irradiated a great number of cells receive irradiation which would subsequently be lodged in distant areas of the hematopoietic system, and not only these cells will be affected but all the progeny which they otherwise would have produced. The objection might be raised to this that great numbers of marrow cells are not commonly seen in the blood. However, it must be recognized that in differential cell counting as ordinarily done only 100 to 500 cells are enumerated and that even in normal blood if great numbers of cells are studied a few progranulocytes can be found. If with a cell count of 10,000 per cubic millimeter there actually were 1 progranulocyte per cubic millimeter, 10,000 cells would have to be enumerated to find this cell with a fifty-fifty probability. Yet that would mean that there were actually 1,000 progranulocytes per cubic centimeter and about 5,000,000 in the blood stream at any one time, and others could be constantly entering and leaving the blood, so that a very significant number of cells might be irradiated during the time of therapy and these in turn might have given rise to a vastly greater number of cells by their subsequent division. This hypothesis, that possibly cells are constantly leaving and entering lymph nodes, spleen and marrow, would also account for the hyperplasia of these structures and would make possible the explanation of leukemia, lymphosarcoma, and Hodgkin's disease as development from a single somatic mutation in one cell, fitting in with the most plausible view of the mechanism of malignancy and yet explaining the apparent multicentric origin of these diseases. The demonstration by Furth and Kahn[5] that leukemia can be

transmitted by inoculation of a single leukemic cell would also fit in with this hypothesis.

If there is no indirect action of irradiation, irradiation should be so given as to reach every abnormal cell. To accomplish this in disseminated processes such as leukemia, lymphosarcoma and Hodgkin's disease, the entire body must be irradiated, which suggests the use of the spray or roentgen-ray bath technique or the use of artificially radioactive substances such as radioactive phosphorus in the therapy of these diseases.

SUMMARY

In quantitative, controlled studies by the method of human marrow culture with interchange of media between irradiated and nonirradiated cultures there was no evidence of an indirect action of irradiation on cells, but the effects could all be explained if the action of irradiation was directly on those cells capable of either amitotic or mitotic division, preventing the onset of division. An explanation is offered for the observed decrease in size of lymph nodes and spleen outside the irradiated area which does not require the production by irradiation of any substance or emanation carried by the blood stream to act at a site remote from the area irradiated.

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A PHOTOELECTRIC TIMING MECHANISM FOR THE AUTOMATIC CONTROL OF ROENTGENOGRAPHIC EXPOSURE*

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I. INTRODUCTION

ONE of the most important factors in the production of diagnostically excellent roentgenograms is correct exposure. It is essential, therefore, that the methods with which roentgenographic exposure techniques are determined be consistently reliable.

In most clinics, measurements of the thickness of anatomical structures under examination and occasionally patients' weights and ages are the principal guides with which roentgenographic technical factors are derived. Unfortunately, these data frequently yield misleading information regarding the roentgen densities of tissues and the resulting films often lack uniformity; this is especially pertinent when pathological processes are present.

The recent development of an exposure meter[2,3] suitable for use in roentgenography has provided a more dependable method for determining exposure techniques. The instrument operates photoelectrically and is similar in basic design to the photographic exposure meters with which everyone is familiar. The essential components include an R.C.A. 929 phototube to the surface of which is applied a fluorescent material, a vacuum tube amplifier, and a microammeter. To use the device, the phototube assembly is placed beneath an anatomical structure to be roentgenographed, a roentgen beam projected through the tissues, and the resulting deflection of the microammeter observed. The exposure time that will insure correct exposure of a film when exposed by a roentgen beam identical to that with which the exposure meter reading is taken then can be calculated from the equation,

$$t = \frac{c}{M s_e} \qquad (1)$$

where t is the exposure time,
M is the exposure meter reading,
s_e is the speed of the roentgenographic film, and
c is a constant.

Mathematical computations may be avoided if the scale of the microammeter is calibrated directly in terms of exposure time.

Although the exposure meter insures roentgenograms of consistently high quality, there is one objection to its use: two exposures, one for taking the exposure meter reading and one for exposing the film, are required for every roentgenogram produced. Recently, efforts to overcome this difficulty have been made. From these investigations a new instrument, a photoelectric timing mechanism, capable of regulating automatically the length of roentgenographic exposure time has been developed. With this device, correctly exposed roentgenograms can be made simply by closing the exposure switch of the roentgen machine. Regardless of the potential applied to the roentgen tube and of the anatomical structure under examination, exposures are terminated automatically when the proper quantity of radiation has been delivered to the film.

The photoelectric timing mechanism, or phototimer, is a modification of the roentgenographic exposure meter. The basic components are illustrated in Figure 1, and include the phototube-fluorescent screen combination, P, the condenser, C, the thyratron, T and the relay, Re. When the roentgen tube, A, is energized by closure

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of the switch, Sw, a roentgen beam passes through the anatomical structure, B, exposes the film, F, and impinges on the phototube-screen assembly, P, mounted directly below the center of the film. In response to the radiation a small current, whose magnitude is proportional to the intensity of the radiation received by the film, flows through the phototube and is collected by the condenser, C. When the potential of the condenser reaches a predetermined level, the thyratron, T, ionizes and the relay, Re, breaks the roentgen-ray circuit and terminates the exposure.

II. THEORETICAL CONSIDERATIONS OF THE PHOTOELECTRIC TIMING MECHANISM

The exposure received by a roentgenographic film is expressed quantitatively as the product of the effective intensity of the incident radiation, G (photographic flux density), and the exposure time, t; that is,

$$E = Gt \tag{2}$$

It has been previously shown[2] that the value of E for correct exposure is a constant;* thus, the conditions for correct exposure are given by the equation,

$$Gt = a_c \tag{3}$$

where a_c is a constant whose value is a function of the speed of the roentgenographic emulsion.

Now it is apparent from Figure 1 that the charge, $\mathcal{Q}$, appearing on the condenser, C, at the end of an exposure is given by the equation,

$$\mathcal{Q} = it \tag{4}$$

where i is the average phototube current and t is the exposure time.

If V is the potential of the condenser, C, at the instant, t, then

$$it = CV \tag{5}$$

* This statement assumes complete fulfillment of the reciprocity law by films exposed with or without intensifying screens. Through the normal range of roentgenographic conditions, the assumption is essentially valid; however, a complete investigation of the reciprocity failure of commercial roentgenographic films is now in progress and will be reported later.

It will be shown presently that the phototube current, i, is proportional within wide limits to the effective intensity of the radiation exposing the film; that is

$$i = kG \tag{6}$$

where k is a constant whose value is a function of phototube sensitivity.

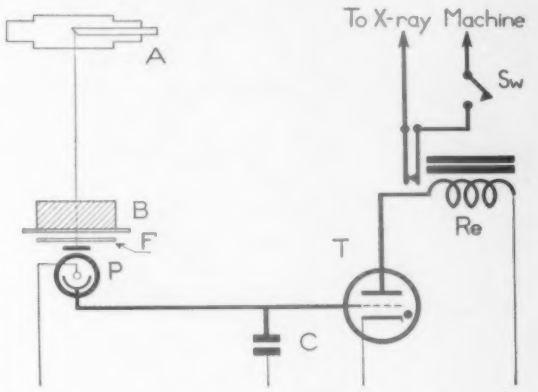

Fig. 1. Schematic diagram illustrating the essential components of the phototimer circuit: P, phototube and overlying fluorescent screen; C, condenser; T, thyratron; Re, relay; and Sw, exposure switch. Also shown are A, a roentgen tube, B, the cross-section of an anatomical structure being roentgenographed, and F, a roentgenographic film.

When i is eliminated from equations (5) and (6),

$$Gt = \frac{CV}{k} \tag{7}$$

From equation (2), the film has been properly exposed when

$$\frac{CV}{k} = a_c \tag{8}$$

Equation (8) can be satisfied simply by adjusting the values of C, V, and k.

In the foregoing discussion it was assumed that the total charge appearing on the condenser, C, was entirely the result of photoelectric action. This, however, is not entirely true. Small quantities of charge are collected from the control grid of the thyratron, T, and through the insulation of the phototube and wiring system. For

satisfactory operation of the timing mechanism, this charge must not be greater than approximately 10 per cent of that originating in the phototube; otherwise the phototimer will tend to act prematurely. Until a short time ago, this criterion was difficult to fulfill since the current output of available phototubes operating under roentgenographic conditions was extremely small. It was possible by using special phototubes constructed of materials having high insulating properties, and by separating phototube and thyratron circuits by amplifier tubes of the electrometer type, to design an instrument that would perform satisfactorily. Such a device, however, would be costly and critical in operation and hardly could be classified as anything but a laboratory instrument, totally unsuited for routine clinical work. A timing mechanism devised by Franke[1] was essentially one of this type. Recently the status of photoelectric timing mechanisms was altered completely by the development of the multiplier phototube.[4,6] This tube, like others of the photoemissive type, contains a light-sensitive cathode but in addition includes a series of so-called electron mirrors or dynodes which amplify by secondary emission the current developed at the photocathode. The dynodes are arranged in sequence and an anode opposite the last collects the amplified photocurrent. The sensitivity of the device is extremely high; even when activated by the small radiation intensities employed in roentgenography its current output is several microamperes. Phototube sensitivity may be controlled by varying the potential applied to the entire tube or to one of the dynodes singly.

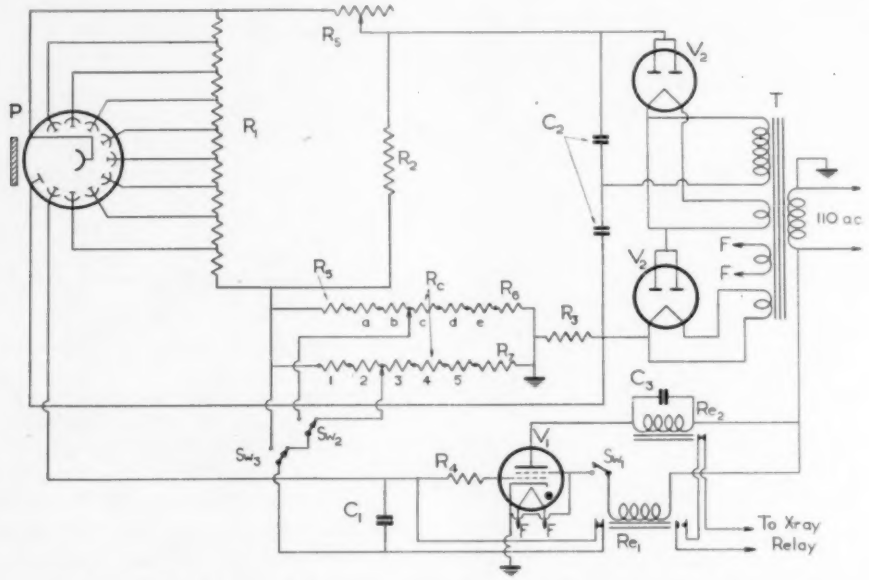

Fig. 2. Schematic diagram of the complete phototimer circuit: P, R.C.A. 931 multiplier phototube; R_1, nine 0.1 meg. resistors; R_2, 0.5 meg. variable resistor; R_2, 0.125 meg. resistor; R_3, 5000 ohm resistor; R_4, 0.1 meg. resistor; R_5, 700 ohm resistor; R_6, 2000 ohm resistor; R_7, 2250 ohm resistor; R_c comprises the following resistors: *a*, 100 ohms; *b*, 200 ohms; *c*, 200 ohms; *d*, 200 ohms; *e*, 600 ohms; *1*, 100 ohms; *2*, 200 ohms; *3*, 300 ohms; *4*, 300 ohms; *5*, 800 ohms; T, 400 volt transformer; V_1, R.C.A. 2051 thyratron; C_1, 0.25 mfd. condenser; Re_1, D.P.D.T. relay; Re_2, S.P.S.T. relay; Sw_1, S.P.S.T. exposure switch, Sw_2 and Sw_3, S.P.D.T. switches; V_2, R.C.A. $_8$W4-GT rectifiers; C_2, 8 mfd., 600 volt condensers; C_3, 8 mfd., 150 volt condenser.

III. Design of the Phototimer

(*a*) *Electrical Considerations.* A schematic diagram of the complete circuit of the phototimer is shown in Figure 2. The nucleus of the system is the R.C.A. 931

multiplier phototube, a device that includes nine dynodes and whose photocathode is identical to that employed in the R.C.A. 929. It is to be observed that the number 9 dynode rather than the anode of the phototube is employed as the control electrode of the circuit. This is necessitated by the fact that the charge delivered to the condenser, C_1, by the anode is of the wrong sign to activate the thyratron, V_1. It may be argued that the number 9 dynode is also an unsuitable control electrode since the charge appearing on the condenser, C_1, during an exposure causes the dynode's potential to become more positive and the sensitivity of the phototube to change. It is true that in general phototube sensitivity is labile to variation in the potential of a single dynode; that this rule, however, does not apply to the last member of a series is well shown in Figure 3 where relative phototube sensitivity is plotted against the potential of the number 9 dynode. It is evident that the electrode's potential can be increased considerably over the normal operating level without causing appreciable diminution in phototube sensitivity.

Phototube and thyratron grid potentials are provided by a voltage-doubling circuit comprising the 400 volt transformer, T, the rectifiers, V_2, the condensers, C_2, and the resistor network, R_1, R_2, R_3, R_5, R_6, R_7, and R_c. It is desirable to supply the primary of the transformer, T, with stabilized 110 volt alternating current. This may be obtained conveniently from the primary filament circuit of the roentgen machine. The same source also may be used to provide the thyratron plate potential.

The photoelectric timing mechanism controls the roentgen machine through the relays, Re_1 and Re_2. When the switch, Sw_1, is closed the relay, Re_1, energizes the main relays of the roentgen-ray circuit and the roentgenographic exposure is begun; the circuit is broken and the exposure terminated by the relay, Re_2, operating in response to the thyratron, V_1. When the switch Sw_1, is opened, the condenser, C_1, is discharged and the thyratron, V_1, deionized by the relay, Re_1; thus the timing mechanism is prepared automatically for the next exposure.

The sensitivity of the system is controlled by the potentiometer, R_s. This device permits the phototimer to operate satisfactorily with any type of film or film-screen combination; correctly exposed roentgenograms are assured simply by rotating the dial of the potentiometer to the position where the sensitivity of the phototube is such that equation (8) is satisfied. It has been found convenient to calibrate the scale of R_s in terms of film speed numbers to facilitate this operation.

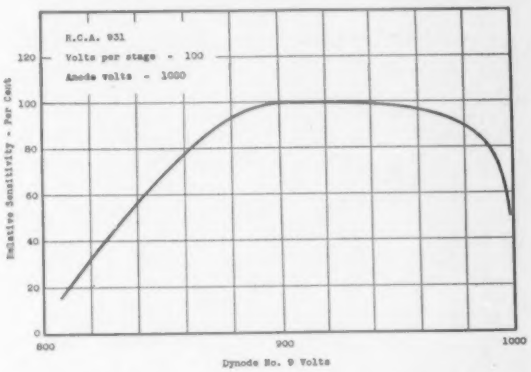

Fig. 3. Relative sensitivity of the R.C.A. 931 multiplier phototube as a function of the potential applied to the tube's No. 9 dynode.

The initial potential of the control grid of the thyratron, V_1, is governed by the voltage divider, R_c; its significance will be discussed later.

(*b*) *Fluorescent Material.* In previous publications[2,3] it was emphasized that the response of an exposure meter (and so too a photoelectric timing mechanism) must be proportional to the effective intensity (photographic flux density) of the radiation received by films exposed with and without intensifying screens (see equation 6); that is, the instrument must be independent of roentgen quality within the range of conditions with which it is used. The extent to which this criterion is fulfilled depends almost entirely on the choice of the fluorescent material used in conjunction with the instrument's phototube. In

the case of an exposure meter, for example, the criterion is satisfied for films *exposed without intensifying screens*[3] when the fluorescent material is a strip of Patterson fluorazure screen; *the same material serves equally well in the phototimer.* It also was pointed out that the most suitable fluorescent material for use in an exposure meter when films are to be exposed *with intensifying screens* is a Patterson type "B" fluoroscopic screen and an overlying aluminum filter, 0.5 mm. in thickness. It has been found that this combination is not entirely satisfactory for use under similar conditions in the phototimer. The reason for this is evident: the cassette and its pair of intensifying screens interposed between the phototube-screen combination and the overlying anatomical structure act as a filter and absorb differentially the radiation passing through them. Thus, the response of the instrument relative to that of the film-screen combination varies with the quality of the radiation.

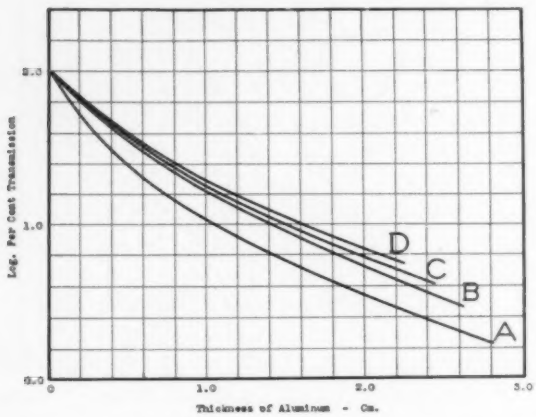

Fig. 4. Four aluminum transmission curves derived from measurements made with A, an exposure meter whose response is identical to those of roentgenographic films exposed with intensifying screens, and B, C and D, a roentgen intensitometer whose radiation detector comprised an R.C.A. 929 phototube and strips of fluorazure, type "B," and cadmium tungstate fluorescent screens respectively; in the last three instances the radiation was filtered through a pair of intensifying screens whose aluminum equivalent is 5 mm. Radiation was provided by a 4 valve roentgen generator operating at 90 kv. (peak). Curve B shows the least deviation from the ideal situation illustrated by Curve A and indicates that the fluorazure screen is the most satisfactory material for use in the phototimer when films are to be exposed with intensifying screens.

It is possible to eliminate to a large degree the filtration effect of the cassette by removing the lead foil lining the back cover. This may be done without fear of reducing roentgenographic quality; in test cases roentgenograms made with cassettes in which half of the lead backing was removed revealed no evidence of the absent portion. Indeed, it appears that the lead is completely superfluous and might better be conserved for more necessary applications elsewhere in the war effort. A further lessening of the filtration effect may be gained by replacing the aluminum covers of the cassettes with a bakelite material. It is felt, however, that this is unnecessary; the aluminum equivalents of various commercial intensifying screens range from 3 to 5 mm. and this is relatively large compared to the thickness of the covers of most cassettes.

To compensate for the filtration effect of the intensifying screens, the phototube's fluorescent material must be one whose response to soft radiation is relatively greater than that of the type "B" screen. The material that approaches most closely complete compensation is the fluorazure screen. This is well shown in Figure 4 where four aluminum transmission curves are presented. The roentgen beam with which these data were obtained was produced by a four-valve roentgen generator operating at 90 kv. (peak). Curve A was prepared from measurements made with an exposure meter in which the radiation detector comprised a type "B" fluoroscopic screen and an aluminum filter 0.5 mm. in thickness. Since the relative response of this instrument is identical to those of films exposed with intensifying screen,[3] Curve A represents the ideal situation. Curves B, C, and D were prepared from measurements made with a photoelectric intensitometer in which fluorazure, type "B," and cadmium tungstate screens respectively were em-

ployed in the radiation detector; in each of the three instances the roentgen beam was filtered by a pair of intensifying screens whose aluminum equivalent was 5 mm. Several types of calcium tungstate screen were also tested; curves similar to C were obtained with these materials. It will be observed that Curve B approaches most closely the ideal condition illustrated by Curve A. For this reason the fluorazure screen has been chosen for use in the phototimer when films are to be exposed with intensifying screens. The size of the screen employed is a strip approximately 1 by 2 inches. As previously noted, the same material is used when films are exposed without intensifying screens.

Since Curves A and B in Figure 4 are not superimposable, it is evident that the response of the phototimer is not entirely independent of roentgen quality when films are exposed with intensifying screens. The effect of variation in roentgen quality on the performance of the instrument was therefore investigated. The response of the phototimer was compared to those of films exposed with intensifying screens through a wide range of roentgenographic conditions. The procedure was carried out by comparing the response of an exposure meter whose radiation detector included a 929 phototube, a type "B" screen, and an aluminum filter, 0.5 mm. in thickness with that of a photoelectric intensitometer whose phototube-screen combination comprised a 929 phototube, a fluorazure screen and an overlying pair of intensifying screens whose filtration was equivalent to 5 mm. of aluminum. As previously mentioned, the response of the exposure meter is proportional to those of films exposed with intensifying screens and the response of the intensitometer is obviously proportional to that of the phototube-screen combination of the phototimer operating under normal roentgenographic conditions. Thus the desired information was obtained without long and tedious densitometric examinations of roentgenographic film.

The radiation with which the measurements were taken was provided by a four-valve roentgen generator operating at potentials of 40 to 90 kv. (peak) and filtered through phantoms of pressedwood ranging in thickness from 0 to 30 cm. Field sizes ranged to 1,000 sq. cm. and measurements were made with and without a 5:1 Potter-Bucky grid. Under each condition studied,

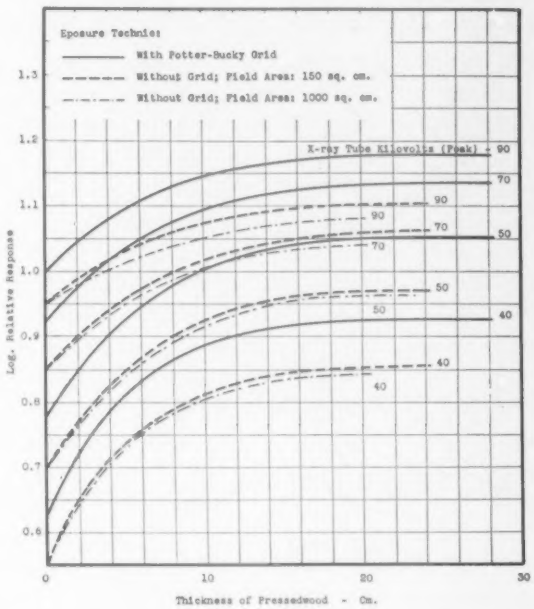

Fig. 5. Log. relative response of the phototube-screen combination of the phototimer operating under various roentgenographic conditions when films are exposed with intensifying screens.

a ratio of the readings of the two instruments was determined. This ratio indicates the response of the phototube-screen combination of the phototimer relative to those of films exposed with intensifying screens at a particular roentgen quality.

The results of the investigation are shown in Figure 5 where logarithms of the relative response of the phototube-screen combination are plotted against phantom thickness for various roentgen tube potentials and field areas. Logarithms rather than real values are used because the former may be interpreted more easily.

Wilsey[5] has shown that a difference of approximately 10 per cent in the exposures received by two roentgenograms is required

to produce perceptible differences in film blackening. It is essential, therefore, that the response of the phototimer remain independent of roentgen quality within ±10 per cent through any particular range of conditions with which the instrument is used if satisfactory performance is to be assured; the corresponding logarithmic variation that is permissible is ±0.05. It is evident that the phototube-screen combination of the phototimer fulfills this criterion when films are exposed *with intensifying screens* under the following conditions:

(1) Films exposed with a Potter-Bucky grid through tissues ranging in thickness from 6 cm. to more than 30 cm.

(2) Films exposed without a Potter-Bucky grid through tissues ranging in thickness from 5 cm. to more than 30 cm. and with field areas ranging in size from 150 to 1,000 sq. cm. and over. These conditions certainly include essentially all of those encountered in clinical roentgenology for films exposed *with intensifying screens*.

It will be observed in Figure 5 that the relative response of the phototube-screen combination of the phototimer is a function of the kilovoltage applied to the roentgen tube, and of the presence or absence of a Potter-Bucky grid. The area of the irradiated field does not seem to be an important factor within the limits that were studied. In order that the overall response of the phototimer may be independent of these factors, the voltage divider, R_c, with which the potential, V (equation 8), of the condenser, C_1, is governed, is introduced into the circuit. In accordance with equation (8), R_c compensates for changes in the response, k, of the phototube-screen combination when the kilovoltage of the roentgen tube is altered and when a Potter-Bucky grid is employed. It has been found convenient to connect the control shafts of R_c and of the major potential selector of the roentgen machine so that the phototimer is adjusted automatically when the kilovoltage applied to the roentgen tube is selected. Since the values of the various resistors comprising R_c depend on whether or not the Potter-Bucky grid is to be used, R_c consists of two networks with the switch, Sw_2, choosing the one to be used. This switch conveniently may be tied in with the exposure switches of the roentgen machine which control grid and non-grid exposures. The values of the resistors in the networks, R_c, were determined from the data provided in Figure 5. When films are to be exposed without intensifying screens no compensation for changes in roentgen tube potential is needed in the phototimer circuit. Thus R_c is excluded from the circuit for non-screen filming by the switch, Sw_3.

IV. INSTALLATION

In a typical roentgenographic application the phototube-screen combination and the resistor network, R_1, are mounted in a light-proof case, approximately 6 by 1.5 by 1.5 inches, directly beneath the center of the film tray of the roentgenographic table. An opening several inches in diameter should be drilled through the tray to permit free passage of the radiation to the phototube assembly. The remaining components of the instrument are mounted on a chassis within the roentgen machine's control stand and the two units connected by a four-conductor cable.

In chest roentgenography it is desirable to include two phototubes, each scanning separate lung fields, in the phototimer circuit. The tubes are placed directly behind the cassette changer, 2.5 to 3 inches on each side of the midline at a level midway between the top and bottom of a film. In order to insure an exposure beginning and ending on the zero point of a cycle (zero line voltage), the main switches of the roentgen machine should be of the ignitron type.

V. OPERATION

The operation of a roentgen machine equipped with a photoelectric timing mechanism is simplicity itself. To make a roentgenographic exposure, a film is inserted in the film tray, the roentgen machine adjusted to any reasonable kilovoltage for the

anatomical structure under examination, the potentiometer, R_3, rotated to the speed number of the film or film-screen combination to be exposed, the switch, Sw_3, adjusted to the screen or non-screen position depending on the technique employed and the exposure made by closing the switch, Sw_1. Calculations of roentgenographic technical factors, critical adjustments of roentgen tube potential and adjustments of posures prematurely or that grid lines will be evident on the roentgenograms.

For several months the photoelectric timing mechanism described above has been in use on the filming-fluoroscope at the University of Chicago Clinics. During each day the instrument is called upon to control between 75 and 150 exposures. The device operates from light emitted from the fluoroscopic screen, a Patterson type "B" model.

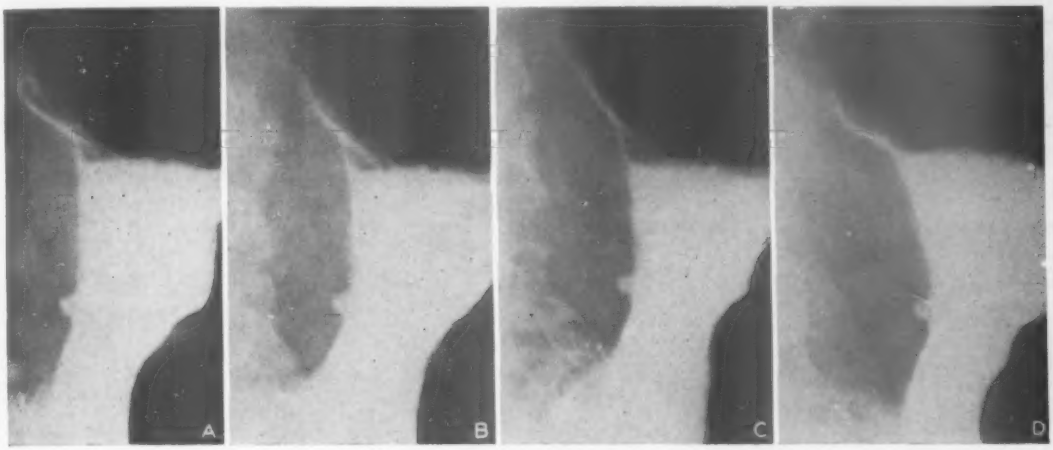

Fig. 6. Four roentgenograms of an ulcerating lesion of the stomach. Technical factors: roentgen tube potential, *A*, 55 kv. (peak); *B*, 65 kv. (peak); *C*, 75 kv. (peak); *D*, 85 kv. (peak); roentgen tube current, 100 ma.; exposure time controlled by the phototimer. The uniformity of the films illustrates the ability of the phototimer to regulate correctly roentgenographic exposure regardless of the technical factors employed.

mechanical or motor-driven timing mechanisms are eliminated completely. The control of exposure by the phototimer is entirely automatic.

When the films are to be exposed through a Potter-Bucky grid the use of the phototimer is complicated somewhat by the problem of adjusting the grid's speed of travel. It is hoped that before long constantly moving grids requiring no regulation will be available, but until then adjustment of the speed of conventional grids should be made by estimating roughly the probable exposure time for the part under consideration (it is impossible, of course, to predict beforehand the exact exposure time), and then setting the time of grid travel at a value 50 to 100 per cent greater than this. If this procedure is followed it is unlikely that the grid will terminate ex-

The ability of the phototimer to regulate correctly and automatically the exposure of roentgenographic films regardless of the technical factors employed and the anatomical structure under examination is well shown in Figures 6 and 7. In Figure 6 are reproduced four roentgenograms of an ulcerative lesion of the stomach exposed with the following technical factors: roentgen tube potential, *A*, 55 kv. (peak); *B*, 65 kv. (peak); *C*, 75 kv. (peak); *D*, 85 kv. (peak); roentgen tube current, 100 ma.; exposure times controlled by the phototimer. Figure 7 includes reproductions of four roentgenograms illustrating *A*, a view of the pharynx and upper esophagus; *B*, a relief view of the stomach; *C*, a view of the filled duodenal bulb with the patient in an oblique position, and *D*, a view of the duodenal bulb with compression; the exposures

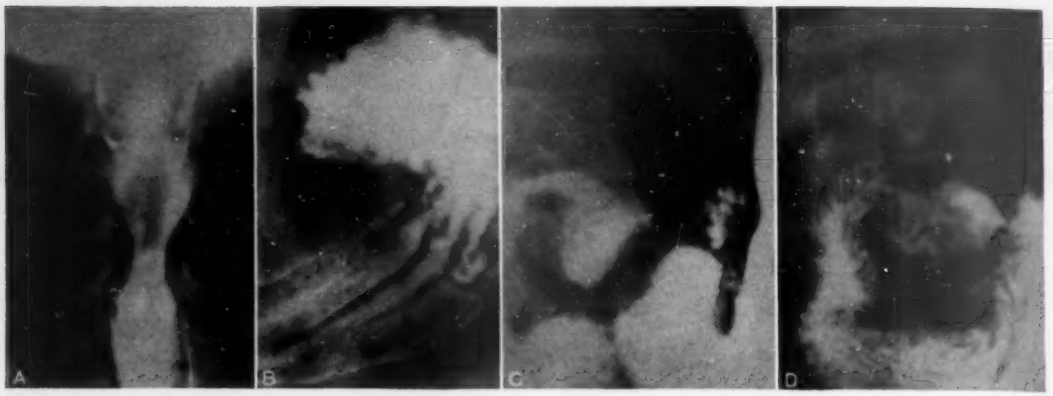

FIG. 7. Four roentgenograms illustrating *A*, a view of the pharynx and upper esophagus; *B*, a relief view of the stomach; *C*, a view of the filled duodenal bulb with the patient in an oblique position, and *D*, a view of the duodenal bulb with compression applied. Technical factors: roentgen tube potential, 85 kv. (peak); roentgen tube current, 100 ma.; exposure time controlled by the phototimer. The uniformity of the average densities of these films demonstrates the ability of the phototimer to regulate correctly roentgenographic exposure regardless of the anatomic structure being filmed.

were made with the following technique: roentgen tube potential, 85 kv. (peak); roentgen tube current, 100 ma.; exposure time controlled by the phototimer. All of the films reproduced in Figures 6 and 7 were processed simultaneously. Although the roentgenographic conditions under which the several films were exposed varied within wide limits, the marked uniformity of the average densities of the roentgenograms is apparent.

VI. SUMMARY

A photoelectric timing mechanism capable of controlling automatically the length of roentgenographic exposure time is described. The theory, design, installation and operation of the instrument are discussed in detail. Regardless of the anatomical structure under examination, the device insures consistently correct exposure of roentgenographic films; calculations of exposure techniques, use of mechanical or motor-driven timing mechanisms and critical adjustments of roentgen tube potentials are eliminated entirely.

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A STUDY OF DIGESTIVE PHENOMENA IN SNAKES WITH THE AID OF THE ROENTGEN RAY*

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LEGEND is rich, scientific knowledge poor, regarding the digestive phenomena purported to occur in the various species of Reptilia. This is particularly true in the case of snakes, yet of the animal species exciting interest in the problems of gastric secretion and digestion, none is greater in interest than the snake. All of us are familiar with the various feats of deglutition and digestion which typify these animals. The literature, however, seems totally devoid of information on the secretory activity of any of the various divisions of the gastrointestinal tract in Reptilia; nothing is known concerning hormonal, nervous or chemical factors which may play an important rôle, and little is known regarding the mechanical factors influencing digestive processes, although, as a result of the work of Patterson,[9] some information is available concerning gastrointestinal motility.

In an attempt to further our knowledge of the physiology of digestion in reptiles, the present study was undertaken. Inasmuch as the ordinary methods of investigation, from the standpoint of probability, appeared to be somewhat difficult and uncertain, two methods of approach were used. The first method utilized roentgen ray, fluoroscope and opaque media; the second method included the usual forms of mechanical (food) and chemical stimuli with an analysis of the stomach contents. To further simplify our studies, large snakes were obtained, a Florida indigo (*Drymarchon corais couperi*) and a large young boa (*Constrictor constrictor*), both specimens being approximately 7 feet in length and in excellent condition. Several smaller specimens were also used, including the more common garter and water snakes (*Natrix sipedon sipedon*) of Michigan, one of which was given a gastric fistula.

EXPERIMENTAL STUDIES

It became of interest to study a few of the changes taking place in the gastrointestinal tract of a large snake following the ingestion of a suitable meal, preferably of some animal whose skeletal system was such as to be readily visualized by roentgen examination following ingestion. For this purpose large, tame, mature laboratory rats were selected as being suitable for roentgen study. The larger snakes facilitated the studies considerably from the standpoint of obtaining satisfactory amounts of gastric secretions by use of the common stomach tube. They also afforded more easily discernible roentgenograms.

Following a preliminary study of the snake's feeding habits and of the exact location of the pylorus and prepyloric area by using barium and roentgen examination, laboratory animals (rats) were fed to the snakes at specific intervals and their subsequent course was followed by roentgenographic study. Warm-blooded animals were chosen as being more suitable than cold-blooded animals for food inasmuch as this would approximate more nearly the normal food of these snakes. Roentgenograms were taken immediately and at various stipulated periods thereafter for a time interval of 120 hours for each trial. Six series of roentgenograms were obtained following five feedings of a single rat and one feeding of two rats and their subsequent digestion by the snakes. Both the indigo and the boa were used with practically identical results. Within the time period of 120 hours the skeletal framework of the ingested animal had usually disappeared.

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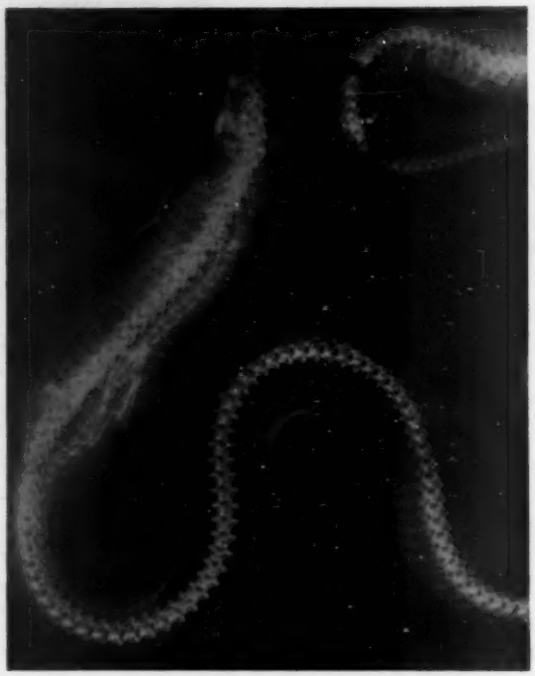


Fig. 1. The position of the ingested rat within the stomach of the snake one hour after feeding. The tail extends into the esophagus, the head lies within the pyloric zone. Multiple fractures are visible. The soft tissue outline of the ingested animal is readily seen.

The studies on digestion were preceded by fasting the animal for a two week period. The laboratory rats which were used weighed on the average 250–300 grams. A single rat was fed on each trial with the exception of a single series in which two rats were fed the boa. The indigo and the boa were used alternately with almost identical roentgenographic findings. Photographic studies were made of the process of deglutition and the following observations made after ingestion occurred. Similar roentgen-ray techniques were used for each roentgenogram. The following is an interpretation of a single series of roentgenograms which are representative of the results observed in the remainder of the series.

One Hour. Immediately following the ingestion of a 250 gram laboratory rat, the skeletal framework could be easily discerned lying within the stomach, the most distal portion (usually the head of the ingested animal) being in the region of the 160th vertebral segment which had previously been determined by means of roentgen study with barium as the site of the pylorus. The tail of the animal extended well up into the esophagus (Fig. 1).

One Hour Thirty Minutes. One and one-half hours later there was no change in position. The ingested animal had assumed a more compact form with a definite curvature of the vertebral segments. The most distal segment was still opposite the 160th vertebral segment of the snake. There were no marked gas shadows within the stomach region.

Four Hours Forty-five Minutes. Four and three-quarter hours after ingestion, large gas pockets began to accumulate within the stomach. The ingested animal was in a more compact position as judged by the location of the various skeletal bones.

Twenty-two Hours. Within twenty-two hours there was a lessening in the density of the skeletal framework which was now less readily discernible. Demineralization was beginning to

Fig. 2. Twenty-seven hours after feeding. Demineralization has already begun. Gas shadows within the stomach region have increased moderately. The head still lies within the pyloric zone with little if any change in the position of the ingested animal.

take place in the skull bones of the ingested animal. There was now a marked accumulation of gas in the stomach region. The most distal segment of the ingested animal was still opposite the 160th vertebral body of the snake. Multiple fractures of the bones of the rat had occurred. Many of these undoubtedly were produced at the time of capture, but were not previously discernible in the roentgenogram.

Twenty-seven Hours. At twenty-seven hours the skeletal framework was much less recognizable. This was particularly true of the rib structures and portions of the head. There was very little change in the position of the skeletal bones within the stomach. There was a slight increase in the gas shadow. Additional fecal material had started to collect within the small bowel, and large gas pockets extended through the entire gastrointestinal tract. The tail of the ingested animal was still within the lower esophagus (Fig. 2).

Forty-seven Hours. At forty-seven hours marked digestive changes had occurred. There had been no progression of the skeletal structures within the stomach region, aside from the bones forming a more compact mass. Multiple fractures were noted. Striking absorption changes had occurred in the bones of the head, neck, ribs and spinal column. The long bones of the legs still retained a dense outline. Gas shadows had increased slightly in the region of the small bowel and cecum. The most outstanding feature was the loss of mineral content in the bones of the rat (Fig. 3).

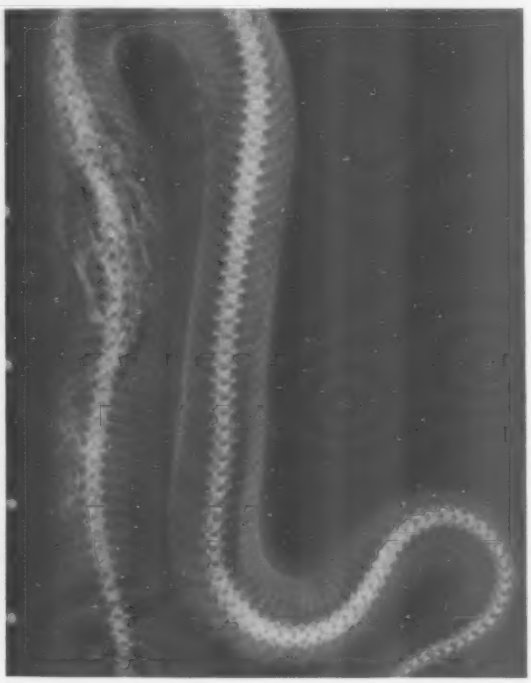


Fig. 3. After forty-seven hours demineralization of the head and ribs is almost complete. The food mass is assuming a more compact form. There has been no alteration of position of the ingested animal as regards its relation to the pylorus.

Fig. 4. The outline of the ingested rat may still be clearly seen seventy-five hours after feeding. The skeletal remains, which have rapidly been demineralized, still lie within the stomach region, but the amount of food material within the small and large bowel has increased greatly. The fecal concretions showing roentgenographic evidence of increased mineral content are outlined by gas shadows.

Fifty-two Hours. At fifty-two hours even greater changes had occurred. The head bones of the rat had practically disappeared. The tail bones were arranged in a circular fashion, due possibly to the digestion of supporting ligamentous structures. The long bones still retained much of their original density. The gas shadows were somewhat diminished in the region of the stomach, but greatly increased within the remainder of the bowel. Fecal material was definitely increased in amount and was outlined by huge gas pockets. The material in the region of the stomach was less compact.

FIG. 5. The small collection of skeletal remains ninety-two hours after ingestion of a rat. These are still within the stomach region undergoing demineralization. The fecal concretions in the remainder of the bowel are again readily seen. Note the roentgenographic detail of the head structure.

Seventy-five Hours. At seventy-five hours no gas shadows were apparent within the stomach region. The skeletal structures had assumed a compact form. All of the bones of the head and vertebrae had been decomposed and could no longer be recognized. The pelvic structures had become less discernible. There was a marked increase in the contents of the small bowel with an increase in their density. There had been no change in position of the stomach contents in relation to the pylorus (Fig. 4).

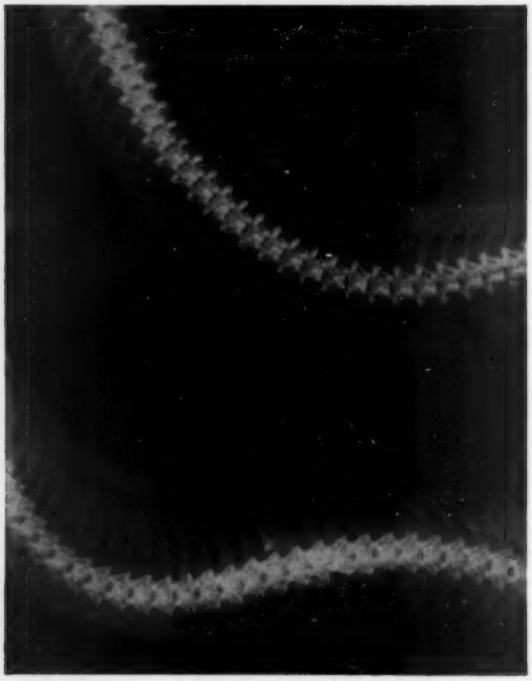


FIG. 6. The only visible skeletal remains still within the stomach 118 hours after feeding are represented by a single femur partially demineralized. All other skeletal structures of the ingested rat have been digested.

FIG. 7. Roentgenogram taken shortly after the placing of barium within the upper esophagus. Multiple peristaltic waves are seen. The length of the esophagus and its simplicity of structure are clearly shown. The stomach is just beginning to fill. Barium previously given is seen within the large bowel.

Ninety-three Hours Thirty Minutes. At ninety-three and one-half hours only a few remnants of the skeletal structures remained within the region of the stomach. These were represented by a few tail bones and two pelvic bones. These

Fig. 9. In this illustration the long course of the single esophagus is outlined with its rather gradual transition into the large stomach which in this instance illustrates its transverse folds. The pylorus is demarcated by a thin stream of barium which then enters the coiled small intestine.

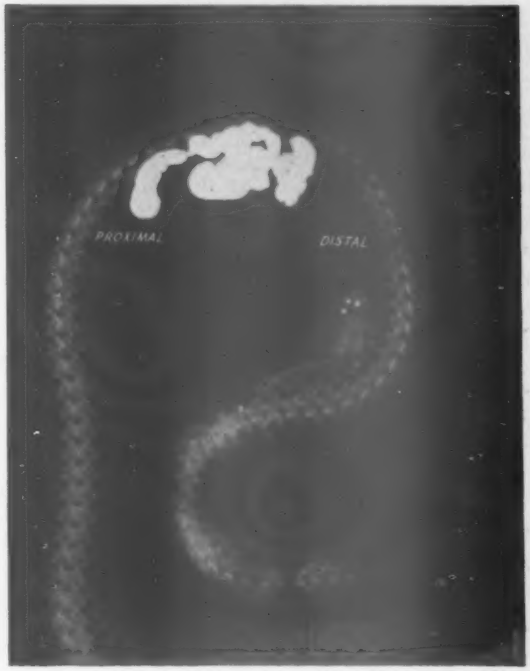
structures were of markedly decreased density when compared with previous roentgenograms. Gas shadows had practically disappeared from the entire gastrointestinal tract. Much of the fecal material had been passed. No skeletal

Fig. 8. Roentgenogram showing the single, extensive, tubular structure of the stomach, the large, well demarcated pylorus, the villous pattern of the small bowel representing a relatively short section of the gastrointestinal tract, and the single tubular outline of the remaining large bowel. The pylorus fails to contain barium as might be expected from such a muscular structure.

structures were present in the bowel other than those seen within the stomach. There was an apparent increase in the density of the fecal concretions (Fig. 5).

Fig. 10. The coiled nature of the small intestine is shown here. This roentgenogram was taken twenty-six hours after the feeding of barium. The small intestine occupies a relatively short section of the entire length of the gastrointestinal tract.

One Hundred and Eighteen Hours. At one hundred and eighteen hours only a faint remnant of one femur remained within the stomach region. Gas shadows were for the most part absent. Fecal material had been added to considerably. No skeletal structures were recognized elsewhere than in the stomach (Fig. 6).



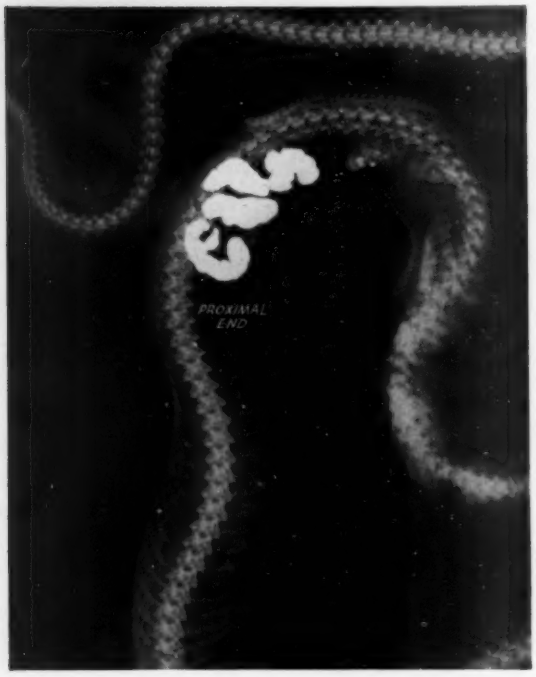


Fig. 11. The coiled small intestine still contained barium forty-six hours after its administration. Since the small bowel probably plays an important rôle in absorption, the ability of such a small segment to retain food over a long interval is significant.

BARIUM SERIES

By utilizing a radiopaque substance (barium sulfate), various phenomena were observed which otherwise could not have been studied. The barium was introduced into the upper esophagus of the snake through a large stomach tube. The snake was then roentgenoscoped and the passage of the barium (via peristalsis) into the stomach was carefully observed. Suitable roentgenograms were taken at intervals to denote the various anatomical divisions of the gastrointestinal tract and their conformations (Fig. 7, 8, 9, 10, 11 and 12). This study was done on both the indigo and the boa on three occasions. The barium roentgen study also served to delineate the most distal portion of the stomach (pylorus) which served as a landmark for interpretation of relative position.

Following the ingestion of barium the esophagus was usually revealed as a long, poorly differentiated tubular structure, extending over a great distance and showing a gradual increase in intraluminal plications as the region of the stomach was approached. There were definite peristaltic waves which were numerous, equally spaced, and typically preceded by an area of dilatation followed by a zone of constriction. The function of the esophagus and stomach was rather poorly demarcated, the stomach extending over a considerable distance as a poorly differentiated, tubular structure showing longitudinal folds, with a very definite pylorus of much smaller caliber than the surrounding bowel.

The small bowel was easily visualized and showed a definite villous pattern extending over a relatively short zone and gradually fading into what was taken to represent a fecal structure. This (cecum or rectum?) was large, segmented, bolus-like, and smooth in outline with loss of continuity.

The most interesting features of the

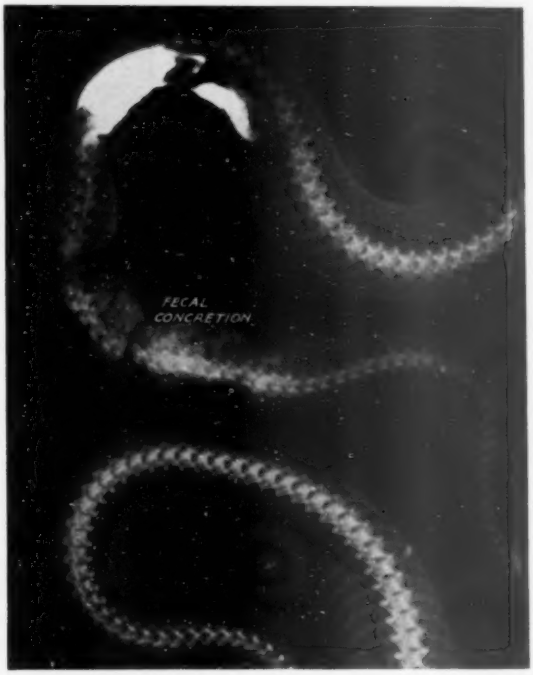


Fig. 12. The formation of fecal concretions within the distal bowel and the simple nature of this segment of the gastrointestinal tract are illustrated here.

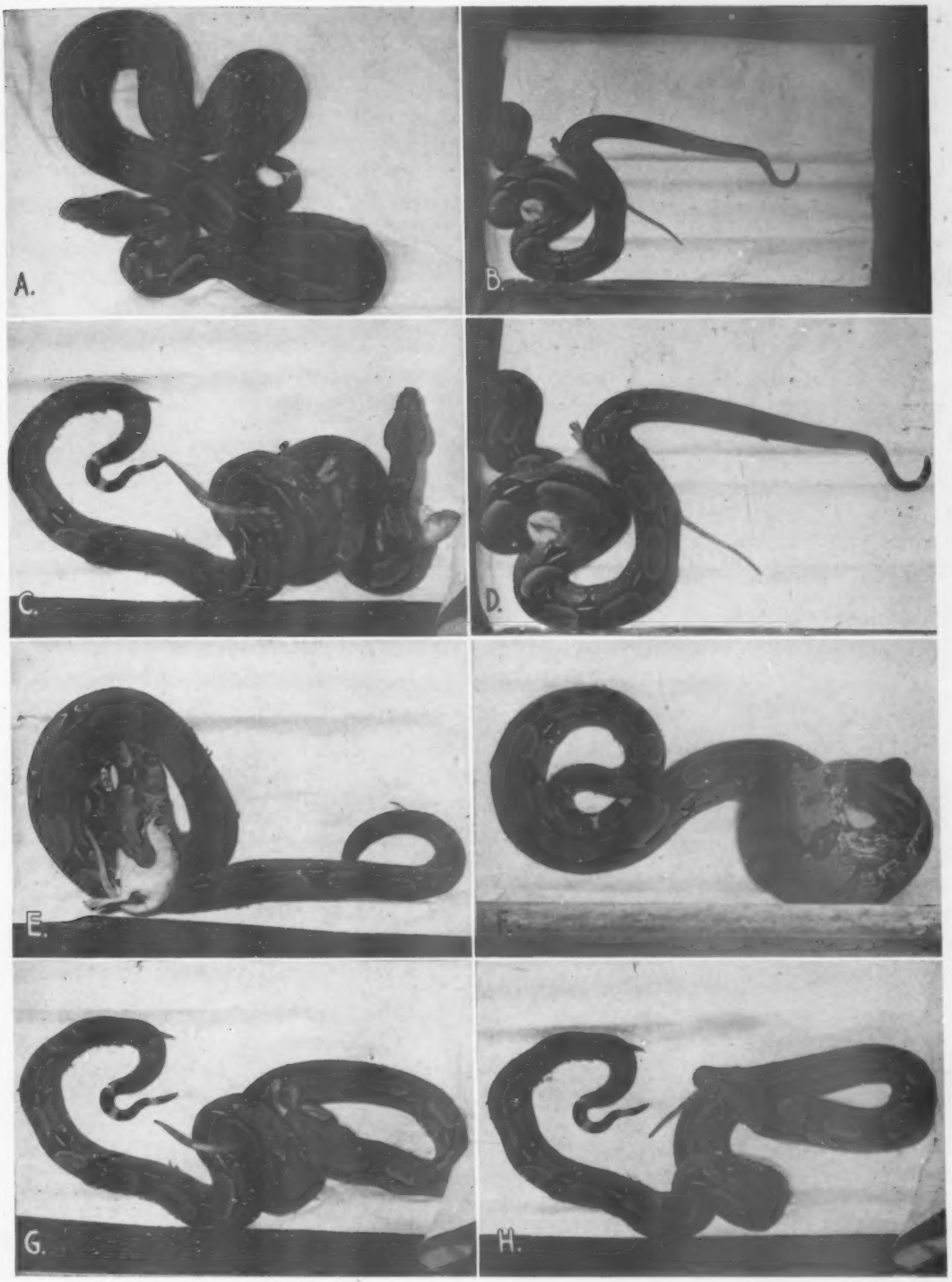


Fig. 13. *A*, *B*, *C*, *D*, *E*, *F*, *G*, *H*. The manner in which the Boa constrictor kills and eats his prey is shown in this series of action pictures taken with a fast-moving camera. Instantaneously, after striking at the prey, the process of crushing it to death begins. In *E* the rat is partially swallowed and in *H* all that remains unswallowed is the tail. The whole procedure takes only a few moments.

study of the gastrointestinal tract using barium were the size and length of the stomach and esophagus, the sharp demarcation of stomach and small bowel at the pylorus, which would probably account for the ability of the snake's stomach to retain a large bolus of food, and the villous pattern of the small bowel which retained barium (by roentgen ray) over a considerably longer period than elsewhere, the barium remaining for fifty hours. The expansion of the stomach could readily be seen in the roentgenogram.

TABLE I

ANALYSIS OF GASTRIC SECRETIONS—120 TRIALS

Drymarchon corais couperi, *Constrictor constrictor* and *Natrix sipedon sipedon*

	Fasting Specimens (40)	Following Food Stimulus (40 specimens)	Histamine	Pilocarpine	Adrenalin	Acetylcholine	Eserine
Quantity	Average 3 cc.	Increased	Increased	Slightly increased	Decreased	Indefinite	Indefinite
Character	Viscid, clear	Watery, clear	Watery, clear	Watery, clear	X	Action	Action
Free acid	Usually absent 4 trials show max. 5–10°	Absent early; present in later trials	Absent in all specimens	Absent	Q.N.S.	Absent	Absent
Total acid	Usually untitratable	Untitratable	Maximum 10°	Untitratable	Q.N.S.	Untitratable	Untitratable
Lactic acid	Present*	Present in first specimen; absent in later specimens	Present and absent depending on stage activity	Present in all specimens	Q.N.S.	Present	Present
Peptic activity	Maximum 4 mett units	No change	Absent	Absent	Q.N.S.	Absent	Absent
Tryptic activity	Absent	Absent	Absent	Absent	Q.N.S.	Absent	Absent
Chloride ion	Present in small amount	Present in small amount	Present in small amount	Not measured	Q.N.S.	Not measured	Not measured
pH average	8.1	7.8	7.4	7.8	Q.N.S.	Q.N.S.	Q.N.S.

* Comparable results obtained in boa, indigo and smaller snakes.

THE CHEMICAL PHASE OF THE PROBLEM

Study No. I. For our first study an attempt was made to obtain gastric juice from the snake's stomach during a period bordering on hibernation. The boa and indigo were used for practically all trials (forty) and the small snakes only on occasion. Gastric intubation was introduced and the residue removed and studied. Similar results were found in all the snakes used (Table I). The material obtained was found to be extremely viscid, clear and rather small in amount, an average of only 3 cc. being obtained at any one trial. Samples were then divided into three equal parts and each was used for peptic, tryptic, hydrometric and qualitative procedures. This allowed for eight examinations of these samples.

1. To determine the peptic activity, small glass tubes of uniform bore filled with coagulated egg albumin were introduced into the juice and incubated at 37° C. for twenty-four hours. In forty trials an average of 0.5 mm. was found digested, excluding three cases where no activity was shown. Expressed in mett units it was shown that 4 units was our maximum figure in all the trials, whereas in the human the average figure for mett units is 100. This would indicate practically negligible peptic activity in the gastric juice obtained from these snakes during a resting period.

2. To determine tryptic activity, Spencer's method was used with a substrate of cosein. No tryptic activity was found in forty trials.

3. Total acidity determinations were made and in all cases the material was found to be untitratable.

4. Free acid was absent in thirty-six trials and found present in amounts of 5°–10° in four trials.

5. Lactic acid was present in forty trials. Yellow ferric lactate identification was made with ferric chloride and a control. The latter was positive in all samples and probably would tend to indicate fermentation.

6. Chloride-ion determinations showed small amounts to be present in all specimens.

7. The average pH of all samples (forty) obtained was 8.1 with a variation between pH 7.8 and pH 8.4.

Study No. II. For our second study, gastric secretions were obtained following food stimulation in the form of white mice. Because of the inactivity of the snakes, the procedure was carried out on only two trials at six day intervals.

1. No change in peptic activity was demonstrated.

2. Tryptic activity could not be demonstrated.

3. Lactic acid was present in easily demonstrable quantities following the first trial, but absent on the second trial. This may indicate that lactic acid is not present during gastric activity and present during hibernation (fasting) or gastric inactivity.

4. Free acid was present in trial 2, absent in trial 1.

5. Total acid was untitratable.

Study No. III. Our third study naturally resolved itself into an investigation of chemical, and therefore possibly nervous factors involved in gastric secretion in snakes. For this purpose eight trials were conducted using histamine, pilocarpine, eserine, acetylcholine and adrenalin as chemical reactants. The boa, the indigo and the water snake were used for these experiments.

1. Histamine Stimulated Juice: The quantity of gastric secretion obtainable following the injection of histamine was definitely increased and of a less viscid nature than previous samples. Eight samples were taken. Analysis:

(a) Total acidity—maximum 10 cc. per 100 cc.
(b) Free acidity—entirely absent in all specimens.
(c) Combined acid—maximum 10 cc. per 100 cc.
(d) Lactic acid—positive and negative—apparently correlated with the stage of gastric function.
(e) No peptic or tryptic activity demonstrated in any specimen.

The conclusions on histamine were that it definitely increased the acidity but had no effect on the proteolytic activity. This is similar to its action in man.

2. Pilocarpine Experiments: In the human species pilocarpine increases peptic activity by acting on the gland cells in the mucosa of the stomach. No such activity could be demonstrated in the snake studies; in fact, no activity of any kind was demonstrated in the snakes used for these experiments. Four samples were taken with the following results:

(a) Peptic activity absent.
(b) Total acid untitratable.
(c) Free acid absent.
(d) Tryptic activity not demonstrable.
(e) Lactic acid present in all specimens.

3. Eserine Experiments: As negative results were obtained on numerous trials, and since eserine is similar physiologically to pilocarpine, further work along this line was discontinued. The work was repeated, however, using a common water snake upon which a gastric fistula had been prepared. The findings were identical with the negative results previously found, and when histamine was used, the results were likewise similar to those obtained in the boa.

4. Adrenalin Experiments: Following the injection of adrenalin, no secretions could be obtained on the boa and the indigo despite numerous attempts. The work was then repeated upon the snake having a gastric fistula. Again no secretions were obtained. These results were taken to indicate a strong inhibitory effect of adrenalin on gastric secretion in the snake.

5. Acetylcholine Experiments: This substance is probably released by all of the postganglionic terminals of the parasympathetic nervous system. When given to the snakes, no effect could be elicited as indicated by an almost complete absence of gastric secretions in both the normal and fistulous snakes.

The chemical studies are difficult to interpret, especially in view of the previous roentgen studies of digestion which showed rapid disintegration of a large quantity of food. The questions which immediately come to mind are: (1) What is the proteolytic enzyme present which we were unable to demonstrate? and (2) Is there a phosphatase present? Roentgen studies showing rapid demineralization tend to confirm this. This is an important point that will bear further chemical investigation.

CONCLUSIONS

As a result of roentgenographic, roentgenoscopic and chemical studies upon a large member of the boa family (*Constrictor*

constrictor) and a large specimen of the Florida indigo (*Drymarchon corais couperi*), as well as numerous smaller grass snakes, the following observations are made:

1. Ingested food is retained within the stomach until total disintegration has occurred. Absorption undoubtedly takes place elsewhere in the gastrointestinal tract. It was felt that the well developed pylorus influenced gastric retention considerably.

2. A satisfactory chemical explanation for the digestion of food within the stomach was not found. The minerals were practically achlorhydric and showed almost negligible proteolytic activity following mechanical and chemical stimulation of gastric secretion. That hydrochloric acid should be present in such small quantities is almost inconceivable, although it is also recognized that certain fish and turtles likewise have low acid values in their gastric secretions.

3. Rapid demineralization of an ingested animal would tend to support the hypothesis that large quantities of phosphatase may be present in the gastric secretions. The demineralization of a large mature rat had begun in twenty-two hours, had progressed considerably within seventy-five hours and was almost complete in one hundred and eighteen hours. During this interval the large bolus of ingested food still remained within the stomach, as demonstrated by serial roentgenograms. This is a considerably longer interval of time for gastric retention than that exhibited in the human species.

4. Histamine stimulated the production of acid but had no effect upon proteolytic activity. This is a finding similar to the action of histamine in the human.

5. Adrenalin inhibited gastric secretion. Pilocarpine, eserine and acetylcholine experiments were rather difficult to interpret inasmuch as little effect was shown and the quantity of gastric juice obtained was extremely small.

6. Evidence of peristaltic activity was obtained by utilizing barium as an opaque medium and observing its passage by use of the fluoroscope.

7. The pylorus in snakes is an extremely well developed structure of considerable size and length. It appears to influence the degree of gastric retention considerably and undoubtedly accounts for the ability of the snake to retain a large mass of food material within the stomach region for a considerable period of time. This structure was readily visualized in the roentgenogram taken after the ingestion of barium.

8. The small bowel is the only coiled portion of the intestinal tract in snakes. The remaining portions are essentially straight, undifferentiated tubular structures which probably serve as absorption areas.

SUMMARY

Each year the literature is filled with reports of new hormones, new theories, more controversies but fewer decided facts regarding gastric secretion in humans. Much has been added since the monumental work of Beaumont, but many questions remain unanswered. Much work has yet to be done in the study of comparative physiology before we can undertake to evaluate the complex mechanisms present in the gastrointestinal tract of the human species.

A study was made of certain digestive tract phenomena occurring in the boa constrictor, indigo and other smaller species of snakes. No satisfactory chemical explanation was found which would account for either the rapidity or degree of digestion of a rather large mass of food. The question is raised of an unknown enzyme being present or the possibility of phosphatase playing a rôle in the breakdown of the food. Further investigation is desirable.

The rôle of roentgenography and roentgenoscopy in furthering our knowledge of comparative physiology in the lower animal species is demonstrated.

Grateful acknowledgment is made to the late Dr. Wie Kim Lim; to Mrs. Helen Thompson Gaige, of the Department of Herpetology, University Museum, University of Michigan, and to Dr. James E. Lofstrom, of the Department of Roentgenology of this Hospital.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: James Ewing, Eugene L. Opie.

Forty-third Annual Meeting: Palmer House, Chicago, Ill., Sept. 15–18, 1942.

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Representatives on American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

Twenty-eighth Annual Meeting: 1943, to be announced.

EDITORIALS

THE ANNUAL MEETING

IN THESE difficult times when all thoughts are turned toward the war and the winning of it, the inconveniences caused to scientific societies have to be endured with equanimity; in such a situation does the American Roentgen Ray Society find itself in making arrangements for its annual meeting. The Executive Council had decided early in the year that the meeting would be held in Atlantic City at Haddon Hall from October 6 to 9, 1942. With this very important feature of the annual meeting settled, President-elect Bromer and his Program Committee set about to secure an adequate scientific program, and one may well understand how difficult it is to organize a program months in advance of a meeting when not only may the chief speakers be called into active service but the discussants as well. Within the last few days the Government has found it necessary to commandeer various hotels, among them Haddon Hall. It therefore became necessary immediately to find another suitable place and it has been decided that the Forty-third Annual Meeting of the American Roentgen Ray Society will be held at the Palmer House, Chicago, Illinois, on September 15, 16, 17 and 18, 1942. The advance in the dates of the meeting was necessary in order to obviate any conflict with other commitments which the Hotel had previously made. The accommodations for the meeting will of course be adequate in every respect. The central location of Chicago and its accessibility by various railroads makes it peculiarly desirable as a meeting place at this time when demands upon the railroads have almost reached their capacity.

Elsewhere in this issue will be found the Preliminary Program which President-elect Bromer and his committee have arranged. It may become necessary between now and the time of the meeting to make certain changes in the scientific program but members of the Society and their guests may be assured that the scientific program will be a splendid one.

In spite of the exigencies of the times the manufacturers have expressed an intense interest in the meeting and an excellent representation in the Commercial Exhibit may be expected.

The committee in charge of the Scientific Exhibit, of which Dr. V. W. Archer is Chairman, has been somewhat apprehensive about the possibility of obtaining an adequate exhibit during these strenuous times. However, from word which has recently been received it is apparent that this feature of the meeting will also not be below the standard which it has maintained in previous years.

As in the last few years, the Instruction Courses will be a part of the program. They are again under the direction of Dr. B. R. Kirklin. The afternoon of each day is to be given over for the most part to the courses. Elsewhere in this issue of the JOURNAL will be found a detailed announcement of the courses with a suitable form to be filled out by those who anticipate taking the courses.

The Golf Tournament will be held on Monday, September 14, and it is hoped that members of the Society, guests and the representatives of the commercial exhibitors will participate in this tournament. Information will be available at the Registration Desk Sunday afternoon and Monday in regard to the tournament.

The Society extends a very cordial invitation to medical officers in all branches of the Armed Forces of the United States to

attend the meeting and it is hoped that it will be possible for many of them to be present.

In spite of the great demands which are made upon the members of the Society at this time, it is to be hoped that each will make a special effort to attend this meeting which is being held at one of the most critical periods in the history of the country.

It is suggested that all who anticipate attending the meeting make their hotel reservations at the Palmer House as soon as possible and also that they make their railroad reservations *well in advance*, not only to Chicago but also for the return trip.

JAMES J. DUFFY
1892-1941

DR. JAMES J. DUFFY died of a heart attack on December 13, 1941. His sudden and untimely demise came as a great shock to his numerous friends.

Dr. Duffy was born in Webster, Massachusetts, May 17, 1892. He graduated from Holy Cross College in 1915 and from the Harvard Medical School in 1919. He joined the staff of Memorial Hospital in New York as an intern in 1921 and at the time of his death he was an Associate Surgeon, in charge of the radium pack. He was also Consultant Surgeon at St. Vincent Hospital, New York; New York Infirmary for Women and Children; St. Mary's Hospital, Brooklyn; St. John's Hospital, Long Island

City; St. Agnes Hospital, White Plains. He was on the teaching staff of Cornell University Medical College as Assistant Professor of Radiology. Dr. Duffy was a member of the American Medical Association, County Medical Society, American Radium Society, Radiological Society of North America, Harvard Medical Society, Celtic Medical Society, and the Harvard Club, and a Fellow of the American College of Surgeons.

Dr. Duffy was well known to radiologists for his contributions to cancer therapy and was especially noted for his balanced judgment in the combined use of surgery and irradiation in accordance with the requirements of each individual patient. He was a firm believer in radiation therapy. In recent years Dr. Duffy had made a special study of skin injuries caused by prolonged exposure to radiation and had acquired great skill in the treatment of these lesions by the beta-ray radon bulb. Many radiological pioneers in this country were relieved of much suffering through his efforts and became his close friends and enthusiastic admirers.

Many men attain a high rank in their profession but only a few possess those intangible human qualities which inspire close friendship and unselfish support. Dr. Duffy was richly endowed with these human qualities. He was a man of high ideals, modest, friendly, and sincere. He was a good companion and a witty entertainer. His loss leaves a void in radiology and in the hearts of all those who knew him.

G. Failla

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual Meeting: Palmer House, Chicago, Ill., Sept. 15–18, 1942.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Annual meeting: 1943, to be announced.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: 1943, to be announced.

Arkansas Radiological Society
Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Drake Hotel, Chicago, Ill., Nov. 30–Dec. 4, 1942.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Section on Radiology California Medical Association
Secretary, Dr. J. D. Coate, 434 Thirtieth St., Oakland, Calif.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

Radiological Section, Los Angeles County Medical Association
Secretary, Dr. Donald R. Laing, 65 North Madison Ave., Pasadena, Calif. Meets on second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.

Buffalo Radiological Society
Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N.Y. Meets second Monday of each month except during summer months.

Chicago Roentgen Society
Secretary, Dr. Warren W. Furey, 6844 S. Oglesby Ave., Chicago, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, J. O. Newton, 13921 Terrace Rd., East Cleveland. Meets at 6:30 P.M. at Midday Club on fourth Monday each month, October to April, inclusive.

Denver Radiological Club
Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida State Radiological Society
Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.

Illinois Radiological Society
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in April.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Louisiana Radiological Society
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society meeting.

Michigan Association of Roentgenologists
Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Hugh F. Hare, Lahey Clinic, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. H. J. Perlberg, 921 Bergen Ave., Jersey City Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

New York Roentgen Society
Secretary, Dr. M. M. Pomeranz, 1020 Park Ave., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

North Dakota Radiological Society
Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Ohio Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati. Meets at time and place of annual meeting of Ohio State Medical Association.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. R. G. Alley, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Sidney Larson, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Annual meeting scheduled for Denver, summer of 1942, has been cancelled.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. H. A. Hill, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months at Toland Hall, second at Lane Hall.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. L. W. Baird, Scott and White Clinic, Temple, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

Virginia Radiological Society
Secretary, Dr. C. H. Peterson, 603 Medical Arts Bldg., Roanoke, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday each month, College Club, Seattle.

X-ray Study Club of San Francisco
Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly in evening on third Thursday.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets monthly on third Thursday from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

Faculty of Radiologists
Secretary, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

Section of Radiology and Medical Electricity, Australasian Medical Congress.
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

Canadian Association of Radiologists
Secretary, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton Alberta.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N.S.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

Continental Europe

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

PRELIMINARY PROGRAM

FORTY-THIRD ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

The Forty-third Annual Meeting of the American Roentgen Ray Society will be held at the Palmer House, Chicago, Illinois, on September 15, 16, 17 and 18, 1942.

The Executive Council will meet at noon on Sunday, September 13.

The Willis F. Manges Memorial Golf Tournament will be held on Monday, September 14.

The Society extends a cordial invitation to medical officers of all branches of the Armed Forces to attend the meeting.

The scientific program has been arranged as follows:

Tuesday, September 15, 1942

8:30 A.M. Call to Order, Forty-third Annual Meeting. William McD. Doughty, M.D., President

Presentation of Medals and Certificates of Merit for Scientific Exhibits at the Forty-second Annual Meeting. President Doughty

Installation of the President-Elect, Ralph S. Bromer, M.D. Bryn Mawr, Pa., by President Doughty and the Chairman of the Executive Council, Lyell C. Kinney, M.D., San Diego, Calif.

9:15 A.M.

Paper No.

1&2. Gastroscopy: From the Standpoint of the Gastro-enterologist. Julian M. Ruffin, M.D., Durham, N.C.

From the Standpoint of the Roentgenologist. B. R. Kirklin, M.D., Rochester, Minn.

3. A Theory of Gastric Motility in Duodenal Ulcer. J. Gershon-Cohen, M.D., Philadelphia, Pa.

4. Metastasis to Bone as the First Symptom of Gastrointestinal Carcinoma. E. J. Bertin, M.D., Philadelphia, Pa.

10:30 to 11:25 A.M. Recess for Study of Exhibits, Scientific and Commercial.

11:30 A.M.

5. Enlargement of the Ileocecal Valve with Report of Two Cases. Ross Golden, M.D., New York, N. Y.

6. Roentgenologic Changes in the Small Intestine in the Presence of the Hook worm. Major George R. Krause, M.C. (by invitation) and 1st. Lt. J. A. Crilly, M.C. (by invitation) Fort Jackson, S. C.

7. Small Intestinal Enema. Richard Schatzki, M.D., Boston, Mass.

8. Sigmoiditis. Stephen L. Casper, M.D., Philadelphia, Pa. (by invitation).

2:00 P.M. Instruction Courses (see page 250)

4:30 P.M. Executive Business Session of the Society.

Wednesday, September 16, 1942

9:00 A.M.

9. Roentgen Diagnosis and Therapy of Ewing's Tumor. Paul C. Swenson, M.D., New York, N. Y.

10. The Pathology and Pathogenesis of Ewing's Tumor of Bone Marrow. Arthur Purdy Stout, M.D., New York, N. Y. (by invitation).

Discussion of papers 9 and 10 to be opened by John T. Murphy, M.D., Toledo, Ohio (ten minutes).

11. Eosinophilic Granuloma: Clinical and Roentgenological Aspects. William T. Green, M.D., Boston, Mass. (by invitation).

12. The Relation of Eosinophilic Granuloma or Solitary Granuloma to the Hand-Schüller-Christian Syndrome. Sidney Farber, M.D., Boston Mass. (by invitation).

13. Prenatal Diagnosis of Albers-Schönberg's Disease. E. L. Jenkinson, M.D., W. H. Pfisterer, M.D. (by invitation), K. K. Latteier, M.D. (by invitation), and Mary Martin, M.D. (by invitation), Chicago, Ill.

10:30 to 11:25 A.M. Recess for Study of Exhibits, Scientific and Commercial.

11:30 A.M.

14. Some Effects of the Roentgen Rays upon the Growing Epiphyseal Cartilages of Albino Rats. C. F. Hinkel, M.D., Harrisburg, Pa. (by invitation).
15. Further Evaluation of 200 kv. Roentgen Rays in the Therapy of Carcinoma of the Cervix Uteri. Charles A. Behney M.D., Philadelphia, Pa. (by invitation).
16. The Rôle of Radiotherapy in Carcinoma of the Fundus Uteri. James A. Corscaden, M.D. (by invitation), Maurice Lenz, M.D., John H. Boyd, M.D. (by invitation), and Haig Kasabach, M.D., New York, N. Y.
17. Damage of the Rectum and Sigmoid Following Irradiation for Carcinoma of the Cervix Uteri. A Follow-Up Study of the Milder Degrees of Injury. Harriet C. McIntosh, M.D., New York, N. Y.

Discussion of papers 15, 16 and 17 to be opened by Dr. Charles L. Martin, Dallas, Texas.

18. Regression of Bone Metastases after Sterilization. Max Ritvo, M.D., and Oscar S. Peterson, M.D. (by invitation), Boston, Mass.

2:00 P.M. Instruction Courses (see page 250)

Wednesday Evening, September 15, 1942
Eight-Thirty O'Clock

The Caldwell Lecture

C. P. Rhoads, M.D.
Director, Memorial Hospital for the Treatment of Cancer and Allied Diseases
New York City
"Newer Aspects of Cancer Research"
Presentation of Medal—President Bromer

Thursday, September 17, 1942

9:00 A.M.

19. Roentgen Anatomy of the Chest: Further Studies with Tomograms. Carleton B. Peirce, Montreal, Canada.
20. Laminagraphic Studies of the Aorta: Its Advantages and Limitations. Donald S. Bottom, M.D., St. Louis, Mo. (by invitation).

Discussion of papers 19 and 20 to be opened by Hugh Wilson, M.D., New Haven, Conn. (by invitation).

21. Intrapulmonary Air Pressure and Its Relation to Pulmonary Capillary Flow. W. Walter Wasson, M.D., Denver, Colo.
22. The Treatment of Asthma with the Roentgen Ray. Ira I. Kaplan, M.D., New York, N. Y.
23. Highlights and Lowlights in the Story of Dusty Lungs. Lewis Gregory Cole, M.D., White Plains, N. Y.

10:30 to 11:25 A.M. Recess for Study of Exhibits, Scientific and Commercial.

11:30 A.M.

24. Roentgen Therapy for Bronchogenic Carcinoma. Bernard P. Widmann, M.D., Philadelphia, Pa. Discussion to be opened by Dr. U. V. Portmann, Cleveland, Ohio.
25. Chronic Radiation Pulmonitis: Studies in Pulmonary Physiology. John E. Leach, M.D. New York, N. Y. (by invitation).
26. The Effect of Heparinization on Post-Irradiation Tissue Changes in the Lungs. Floyd Boys, M.D. (by invitation), and Ivor David Harris, M.D. (by invitation), Charlottesville, Va.
27. Spray Irradiation of Polycythemia Vera. Laurence L. Robbins, M.D. (by invitation), Boston, Mass.
28. Cold and Its Relation to Irradiation Damage. H. D. Kerr, M.D., and T. C. Evans, M.D. (by invitation), Iowa City, Iowa.

2:00 P.M. Instruction Courses (see page 250)

4:30 P.M. Executive Business Session of the Society.

Thursday Evening, September 17, 1942

The Annual Banquet

Speaker: Colonel Fred W. Rankin, Medical Corps, U. S. Army

Friday, September 18, 1942

9:00 A.M.

29. Some Considerations Concerning the Reports of Deaths and Shock after the Use of Dye in Urography. Eugene P. Pendergrass, M.D., Philadelphia, Pa.

30. A Very Accurate Conjunctival Test for Sensitivity Prior to Intravenous Urography. Vincent W. Archer, M.D., and Ivor David Harris, M.D. (by invitation), Charlottesville, Va.
31. Hypersensitivity to Diodrast Determined by Skin Test. Samuel A. Robins, M.D., Boston, Mass.
32. The Value of Excretory Urography in the Interpretation of Renal Function. Karl Kornblum, M.D., and Theodore R. Fetter, M.D. (by invitation), Philadelphia, Pa.
33. Lesions of the Ureter. Lieutenant Commander A. E. Bothe, Med. Corps, U. S. Navy, Bethesda, Md. (by invitation).

10:30 to 11:25 A.M. Recess for Study of Exhibits, Scientific and Commercial.

34. Preliminary Clinical Observations on the Use of Three Million Volt Roentgen Rays. Richard Dresser, M.D. Boston, Mass.
35. The Production and Characteristics of Three Million Volt Roentgen Rays. Professor John Trump (by invitation), and Robert W. Cloud, M.S. (by invitation), Boston, Mass.
36. Radiation Equipment at the Memorial Hospital. G. Failla, Ph.D., New York, N. Y.
37. Ionization Oscillograms. Robert B. Taft, M.D., Charleston, S. C., and George C. Henny, M.D., Philadelphia, Pa.
38. A Group of Persons Whose Skin and Subcutaneous Tissues are Unusually Sensitive to Roentgen Rays. A. U. Desjardins, M.D., Rochester, Minn.

2:00 P.M. Instruction Courses (see page 250)

AMERICAN ROENTGEN RAY SOCIETY

SECTION ON INSTRUCTION

B. R. KIRKLIN, M.D., *Director*

Abstracts of Courses Offered

Forty-third Annual Meeting
Palmer House, Chicago, Illinois
September 15–18, 1942

President-Elect Bromer has arranged his program for this year so that the Instruction Courses will be given between the hours of 2:00 P.M. and 4:30 P.M. on Tuesday, Wednesday and Thursday, and 2:00 P.M. and 3:15 P.M. on Friday. Nothing else will be scheduled during these hours, thus allowing everyone at the meeting to attend the Instruction Courses each afternoon.

This Section presents for 1942:

1. Five Special Sequential Courses, lettered "A" to "E," with a faculty of seven instructors and covering seventeen periods.
2. Six single-period courses on Radiation Physics, with a faculty of six instructors and covering six periods.
3. Ten single-period courses on Therapeutic Radiology, with a faculty of ten instructors and covering twelve periods.
4. Twenty-seven single-period courses on Diagnostic Roentgenology, with a faculty of twenty-four instructors and covering thirty-five periods.

GENERAL INFORMATION

Conference Periods

Tuesday, Wednesday, Thursday and Friday afternoons

First period.....2:00 to 3:15
Second Period.....3:30 to 4:45

Location

All courses will be given in rooms located on the seventh floor of the Palmer House. Full information may be secured at the general registration desk which will be located on the fourth floor.

Code

The instruction periods will be designated with the following code:

T-1	Tuesday, first period	2:00 to 3:15
T-2	Tuesday, second period	3:30 to 4:45
W-1	Wednesday, first period	2:00 to 3:15
W-2	Wednesday, second period	3:30 to 4:45
Th-1	Thursday, first period	2:00 to 3:15
Th-2	Thursday, second period	3:30 to 4:45
F-1	Friday, first period	2:00 to 3:15

(Familiarity with this code will avoid much confusion)

How to Secure Tickets for Instruction Courses

Admission to the Instruction Courses will be by ticket only.

Following page 260 will be found a general order sheet. First, second and third choices for each period should be carefully selected as the number attending each course given during these periods will be limited to from thirty to forty persons. If directions as given on the order sheet are followed explicitly, errors in completing reservations will be minimized.

If you are requesting registration in one or more of the Special Sequential (continuous) Courses, please indicate for each period your second and third choices of individual single-period courses as substitutes—to avoid disappointment should the Sequential Courses be filled when your order is received.

It is possible for one to attend only seven periods of instruction, so the condensed schedule should be noted carefully in arranging individual orders for tickets.

Reservations will be made in the order of receipt of the order forms. Those who are not members of the American Roentgen Ray Society will be charged a nominal fee of $1.00 per period, or a maximum fee of $5.00 for five or more periods. Full time graduate students in Radiology will be admitted without fee.

Previous to September 5, send orders to Dr. B. R. Kirklin, Rochester, Minnesota; after September 5, send orders directly to Dr. B. R. Kirklin, Palmer House, Chicago, Illinois.

If the courses are not filled by the time of the meeting, tickets will be available at the Registration Desk, located on the Fourth Floor, on Monday, September 14, and thereafter during the meeting.

Holders of Tickets

Those who do not have a proper ticket for the assigned course will not be permitted to enter the room. Pages will be assigned to each conference room to collect tickets.

Duplications and Repeats

Due to the anticipated heavy registration a few of the single-period courses will be repeated and others will be duplicated by two or more instructors.

SEQUENTIAL COURSES

COURSE: A
(2 periods)

Room: 732 **Periods: Th-2; F-1**

S. W. DONALDSON, M.D., Ann Arbor, Michigan
Medical Jurisprudence as Applied to Radiology

This course will take into consideration the relationship between physician and patient and the various contracts entered into between them. Malpractice will be defined and consideration given to all acts of the radiologist that may be subject to allegation of negligence or other grounds for suit. The Law of Agency will be discussed and its application to the radiologist in regard to his liability for the acts of those employed by him. Pointers will be given about malpractice defense and prophylaxis. The legal requirements for the introduction of films as evidence in courts of law will also be taken up as well as that for physician's records and hospital records. There will be discussion of privileged communications as related to roentgen examinations, the admissibility of evidence, expert testimony, expert witness fees, and court room procedure for the witness.

COURSE: B
(3 periods)

Room: 722 **Periods: Th-1; Th-2; F-1**

ROSS GOLDEN, M.D., New York City
PAUL C. SWENSON, M.D., New York City

Roentgenology of the Small Intestine

Tuesday

- Technique
- Normal small intestine
  - Anatomy
  - Physiology
- Indications for small intestine study
- Diverticula
- Disturbances in physiology
  - Emotion
  - Vagotonia
  - Multiple peritoneal adhesions
- Developmental anomalies
  - Internal hernia
  - Congenital diaphragm
- Effect of disease of the mesentery
  - Localized
  - Generalized
    - Lymphoblastoma
    - Sclerosing mesenteritis

Wednesday

- The "Deficiency Pattern"
  - Vitamin deficiency states
  - Hypoproteinemia
  - Biliary tract disease
  - Pancreatic disease
- Allergy
- Inflammations
  - Tuberculous
  - Non-tuberculous
    - Sclerosing regional enteritis
    - Non-sclerosing regional enteritis

Thursday

- Neoplasms
  - Benign
  - Malignant
    - Carcinoma and carcinoid
  - Lymphosarcoma
    - Localized
    - Diffuse
- Benign ulcer
- Ileus
  - Diagnosis by 3 position abdominal films
    - Paralytic
    - Mechanical
    - Mesenteric vascular occlusion

The Miller-Abbott tube
Technique of insertion
Deflation
Injection of barium for
1. Localization
2. Demonstration of type of obstruction
Complications

COURSE: C
(4 periods)

Room: 736 **Periods: T-1; T-2; W-1; W-2**

KARL KORNBLUM, M.D.,
Philadelphia, Pa.

Roentgenology of the Urinary Tract

Tuesday (first period)

The Plain or Flat Film Examination
Anatomy of the urinary tract.
Preparation of the patient.
Technique of the roentgen examination.
Retrograde Pyelography
History.
Technique.
A new urological table.
Pyeloscopy.
The normal ureteropyelogram.
Sources of error in interpretation.
Intravenous or Excretory Urography
History.
Technique.
Interpretation of renal function.
Retrograde Pyelography versus Excretory Urography

Tuesday (second period)

Malpositions of the Kidney
Congenital (ectopic).
Acquired (dystopic).
Urinary Calculi
Location.
Characteristics.
Diagnosis.
Differential diagnosis.
Etiology.
Pyelectasis and Ureterectasis
Due to: Simple mechanical obstruction.
Etiology.
Inflammation.
Pyelitis.
Pyelonephritis.
Pyronephrosis.
Neoplasm.
Pyelonephritis
Roentgenological classification.
Acute pyelonephritis.
(so-called pyelitis).
Chronic pyelonephritis.
Atrophic pyelonephritis.
Healed pyelonephritis.
Recurrent pyelonephritis
Relationship to hypertension.
Perinephric Abscess

Wednesday (first period)

Tuberculosis of the Urinary Tract
Neoplasms of the Kidney and Ureter
The Bladder
Cystography.
The normal bladder.
The abnormal bladder.
The Urethra
Urethrography.
The normal urethra.
The abnormal urethra.

Wednesday (second period)

Congenital Anomalies of the Urinary Tract
Ectopic kidney.
Horseshoe kidney.
Duplications of the urinary tract.
Congenital polycystic kidney.
Congenital megaloureter.
Ureterocele.
Valve in posterior urethra.
Exstrophy of the bladder.
Traumatic Lesions of the Urinary Tract
The Urinary Tract in Pregnancy

COURSE: D
(4 periods)

Room: 722 **Periods: T-1; T-2; W-1; W-2**

JOHN T. MURPHY, M.D., Toledo, Ohio
THOMAS RAMSEY, M.D., Toledo, Ohio

Radiologic-Pathologic Conference on Tumors of Bone

This course will be conducted as a radiologic-pathologic teaching seminar and all those in attendance may participate in the discussion.

Both the roentgenologic and microscopic findings of tumors of bone will be shown and discussed. The clinical course of the cases shown will be stressed and a complete follow-up of each patient will be presented. Considerable time will be devoted to the differential roentgenologic diagnosis.

This is a Sequential Course and no part of it will be repeated.

COURSE: E
(4 periods)

Room: 724 **Periods: T-1; W-1; Th-1; F-1**

W. WALTER WASSON, M.D., Denver, Colo.

The Anatomy, Physiology, and Mechanics of the Chest as a Basis for the Study of Chest Diseases and Their Classification

This is an effort to portray the chest so that the clinician or radiologist can actually visualize the

thoracic viscera and their diseases. A child begins life with certain anatomical structures which change with the years both as a result of physiological processes and disease. The pathological reactions which the clinician or the radiologist is called upon to diagnose are definitely influenced by the particular physiology and mechanics of this anatomy. Accordingly, any classification of chest disease must be based upon the pathological reactions of disease as influenced by anatomy and of the physiology and mechanics of this anatomy.

The presentation will be made in the following sections.

1. Anatomy of the Lungs. Period: T-1
2. Physiology and Mechanics of the Chest and Particularly of the Lungs. Period: W-1
3. The Classification of Diseases of the Lungs. Period: Th-1
4. Illustrations of the Different Diseases of the Lungs and their Diagnosis. Period: F-1

SINGLE PERIOD COURSES

RADIATION PHYSICS

COURSE: 101

Room: 734 **Period: T-1**

OTTO GLASSER, Ph.D., Cleveland, Ohio
U. V. PORTMANN, M.D., Cleveland, Ohio

Dosage Measurements with the Thimble Chamber in Practice

The historical development of thimble chamber dosimeters, their calibration in roentgens, the measurement of quantity and quality, depth dose and back-scattering in phantoms will be discussed. The difference between the thimble chamber dosimeters and other types of dosimeters will be discussed. Likewise, the clinical applications of the thimble chamber will be discussed.

COURSE: 102

Room: 734 **Period: T-2**

GEORGE C. HENNY, M.Sc., M.D., Philadelphia, Pa.

Roentgen Film Characteristics and the Practical Calibration of Roentgenographic Apparatus and Processing Solutions

The characteristics of the roentgen film emulsion (together with intensifying screens if they are used), in which the roentgenologist is mainly concerned, are the "speed" and the "contrast." These characteristics are of great importance.

The "speed" determines the degree of darkening of the processed film, after standard development, for a given roentgenographic exposure and a particular anatomic part.

The "contrast," under the same conditions, determines the degree to which tissue density-differences and thickness-differences of the anatomic part will be recorded on the roentgenogram.

For uniformity of results the roentgenographic apparatus and processing solutions should be calibrated at regular intervals. Fairly simple methods of calibration, which are accurate enough for the purpose, are described and may be employed in the roentgen department without great outlay of time or money. When properly employed the roentgenograms of a given patient show uniform density from one examination to the next and the detail of the anatomic parts being studied is, as far as the film emulsion is concerned, brought out to the greatest degree.

COURSE: 103*

Room: 734 **Period: W-1**

EDITH H. QUIMBY, Ph.D., New York City

Artificial Atomic Disintegration

This course will be essentially a general descriptive outline of methods of producing atomic disintegration, and of the products thus obtained. Neutrons and artificially radioactive substances will be discussed in some detail. Brief mention will be made of various biological and clinical uses to which these materials have been put, up to the present time.

COURSE: 104

Room: 734 **Period: W-2**

LAURISTON S. TAYLOR, Ph.D., Washington, D. C.

The Measurement of Quantity and Quality of Roentgen Rays

A general discussion, aimed at showing the necessity for roentgen-ray quantity and quality measurements, will be presented. A brief outline of the fundamental principles involved in the application of roentgen-ray standards will be given. A few examples of actual cases involving the application of physical dosage measurement will be carried through. Likewise the method of determining an absorption curve will be illustrated and the information obtainable therefrom discussed. No discussion of tissue dosage or related subjects will be given.

* This course will not be given.

COURSE: 105

Room: 734 **Periods: W-1; Th-1**

J. L. WEATHERWAX M.S., Philadelphia, Pa.

Radium Dosage

A brief discussion of the disintegration cascade of radium; active deposit; differentiation of radium compared to radium emanation or radon; absorption by different filters and thicknesses of filter; half-life and average life of radon; types of radium applicators; interstitial irradiation; expression of dosage in terms of milligram-hours, millicurie-hours; millicuries-destroyed and a discussion of an attempt to express dosage in roentgens.

An outline will be furnished with a bibliography.

COURSE: 106

Room: 734 **Period: Th-2**

MARVIN M. D. WILLIAMS, Ph.D.
Rochester, Minnesota

Absorption of Roentgen Radiation

1. Introduction. A brief review of the wave and quantum theories of radiation and of atomic structure.
2. Absorption. General considerations. Characteristic absorption bands and secondary radiation. Photoelectric absorption. Compton and unmodified scattering. Absorption of high-speed electrons.
3. Applications. The modification of radiation produced by filters. Some primary effects produced in tissue by the absorption of radiation and the dependence of these effects on the quality and quantity of the radiation.

THERAPEUTIC RADIOLOGY

COURSE: 201

Room: 732 **Period: Th-1**

E. C. ERNST, M.D., St. Louis, Mo.

Practical Concepts of Radiation Treatment of Carcinoma of the Cervix Uteri

SYNOPSIS

(a) *Clinical Management and Preliminary Considerations*

(b) *Indications for Roentgen Therapy:*

1. Indirect irradiation of the pelvis.
2. Direct (intravaginal) roentgen-ray applications.

(c) *Essential Tumor Dose Measurement Factors*

(d) *Indications for Radium Therapy:*

1. Evaluation of the various methods and the intracervical applicators.
3. Essential minimum requirements for obtaining the ideal uniform distribution of the radium radiations.

(e) *Prognostic Factors:*

1. Tumor grading.
2. Stage of the disease.
3. Initial response to preliminary roentgen irradiation.

(f) *Final Discussion Period:*

1. Case presentations.
2. Questions (15 minutes).

ABSTRACT

The practical irradiation management of carcinoma of the cervix will be discussed both from the standpoint of the institutional tumor clinic and the private office procedure. Although realizing that the radiation treatment standards continue to remain somewhat in a state of flux and that individualization in the application of roentgen rays and radium is a most essential consideration, nevertheless certain fundamental concepts in our routine procedures are most helpful in the management of cancer of the cervix. These and many other practical therapeutic considerations, including external roentgen therapy, intracavity radium and roentgen methods of treatment and the dosage measurement problems, will be discussed and illustrated.

COURSE: 202

Room: 754 **Period: W-2**

MAURICE LENZ, M.D., New York City

Roentgen Therapy of Lymphoblastoma

In spite of initial radiosensitiveness of the pathologic tissue, radiocurability of lymphoblastoma is low. In leukemia, roentgen therapy is manifestly only a palliative measure as by this treatment one attempts to control only one of the manifestations of the disease and not the cause of the disturbance in the process of lymphopoiesis and myelopoiesis. Those patients with leukemia, Hodgkin's disease and lymphosarcoma who show a tendency to chronicity do better with roentgen therapy than those whose natural clinical course is more acute. In Hodgkin's disease, survival after roentgen therapy varies in direct proportion to the extent of the disease when treatment is started. In lymphosarcoma, patients whose disease is localized do better than those with more extensive spread. Gastrointestinal lymphosarcoma seems to run a more benign course than other types. The average survival in giant follicle lymphosarcoma is five years; it is closer to three years in the reticulum and lymphocytic cell types.

The insidious spread of lymphosarcoma and Hodgkin's disease suggests that prophylactic roentgen therapy is indicated to the regional lymph nodes which drain the clinically appreciable diseased foci. The details of the technique of roentgen therapy of these diseases as carried out at the Presbyterian Hospital will be given and compared with the methods in use in other clinics.

COURSE: 203

Room: 752 **Period: Th-2**

T. LEUCUTIA, M.D., Detroit, Mich.

Radiation Therapy of Bone Tumors

(1) Osteogenic sarcoma. Radiation therapy is used in association with surgery in pre- or postoperative form in all types, except the pure osteolytic type, in which it is used alone. In the inoperable group, irradiation produces definite symptomatic relief. The five year survival for the entire series amounts to 17 per cent.

(2) Giant cell tumor. Here radiation therapy is the method of choice. There are two requisites: (*a*) irradiation must be carried out with gradually decreasing doses for nearly two years, and (*b*) a limited use of the affected bone must be made so as to prevent marked demineralization from disuse. The final results are, with few exceptions, good.

(3) Ewing's tumor. In the very early cases, radiation therapy may lead to occasional five year survival; in the others, only palliation is obtained, although the immediate response is often striking.

(4) Multiple myeloma. Radiation therapy leads to limited symptomatic relief, but no cure is possible.

(5) In the group of benign tumors, radiation therapy is of definite value in chondroma, myxoma, hemangioma, cystic conditions, etc.

The detailed procedure is presented in the various groups and the technique of irradiation illustrated. Final statistical data are included.

COURSE: 204

Room: 705 **Period: W-2**

CHARLES L. MARTIN, M.D., Dallas, Texas

Complete Care of Cancer of Mouth and Lip Including Cervical Metastases with Irradiation Alone

A plan for the complete radiological care of all stages of cancer of the mouth and lip will be described. Although both radium and roentgen rays are used, the equipment is relatively inexpensive and the time of treatment is short. Much emphasis will be placed on the intensive irradiation of metastatic cervical glands, using a combined roentgen-ray and interstitial radium technique, which has yielded some very promising results. Detailed descriptions of the procedure used in a number of actual cases have been prepared for presentation.

COURSE: 205

Room: 738 **Periods: T-1; W-1**

E. A. MERRITT, M.D., Washington, D. C.

Technique of Treatment of Cancer of the Cervix and Results Therefrom

This presentation is intended neither as a lecture nor as an instruction course; however, it embraces a complete description of a technique covering the radiation treatment of all stages of carcinoma of the cervix uteri.

The advantages of roentgen over radium therapy will be emphasized and a method of treating the cancerous cervix through specially designed specula will be described.

Hospitalization of the patient is rarely necessary, infection is reduced to a minimum; anesthetics and surgical trauma of the cervix completely avoided; severe roentgen sickness and undue skin reactions almost completely controlled.

It provides the radiologist with a standardized technique which will facilitate future statistical comparisons, and divorces therapy of cancer of the cervix from all of the unnecessary and expensive surgical procedures and dangers associated with the use of radium.

Lantern slides, a wax model, and specula employed will serve to clearly demonstrate the method in actual operation.

Results covering a three year period will be stated.

COURSE: 206

Room: 705 **Period: T-2**

WILLIAM S. NEWCOMET, M.D., Philadelphia, Pa.

Radium Therapy of Hemangiomata

Recent articles mention the fact that hemangiomata frequently disappear and this has led many physicians to defer treatment. Seventy per cent of these tumors enlarge during the first few months of life. The port wine mark is usually noticed at birth and rarely changes in size. Plea for early treatment. Early methods used in the treatment of hemangiomata. The application of roentgen rays and radium; the differences between them.

Varieties of hemangiomata from the standpoint of pathologist, dermatologist, surgeon, and radiologist.

Possibility of malignant degeneration, those treated by irradiation and those of unknown origin in youth and adult life.

Spontaneous ulceration and ulceration occurring during treatment, other complications; local lack of

growth, deformity due to tumor, dermatitis, local and general, telangiectasis and lack of function of affected parts.

Discussion of treatment in the young infant, child and adult.

General review of groups and individual cases with emphasis upon unusual bone change, observed in different types.

Results observed immediately after treatment and ten to twenty years later.

COURSE: 207

Room: 752 **Periods: Th-1; F-1**

G. E. PFAHLER, M.D., Philadelphia, Pa.

Radiation Treatment of Cancer of the Breast

The technique for the treatment of cancer of the breast cannot be standardized. The treatment will be demonstrated for cancer of the breast in various stages, including positioning of patient for treatment.

There will also be a demonstration of some of the cases treated primarily and completely by irradiation, also preoperative and postoperative irradiation, including the management of recurrences.

COURSE: 208

Room: 754 **Period: Th-2**

GORDON E. RICHARDS, M.D., Toronto, Canada

Radiation Treatment of Oral Cancer

This discussion will deal with the treatment of cancer of the tongue, buccal mucosa, alveoli and soft and hard palate.

The greatest advance of the past ten years in the treatment of oral cancer has been a better understanding and more effective use of external and intraoral applications of roentgen rays combined with radium under certain conditions. In previous courses the subject of treatment of cancer of the tongue and buccal mucosa has been covered. In the present one the discussion is extended to include the alveoli, where the adoption of the methods outlined have resulted in a marked reduction of complications due to radionecrosis of bone, secondary infection as well as necrosis of soft tissue, resulting in slow healing and pain, most of which can be avoided by the adoption of methods of external irradiation. The course will be illustrated by colored lantern slides and graphic and statistical charts.

COURSE: 209

Room: 734 **Period: F-1**

ROBERT B. TAFT, M.D., Charleston, S. C.

Dosage Measurement from a Clinical Standpoint

The instructor will describe briefly and show photographs of all the methods in use today for roentgen-ray measurement, stating the advantages and disadvantages of each. Illustrations should be obtainable from manufacturers, which will be shown as lantern slides. The value of the "roentgen" as a clinical unit will be discussed. Pros and cons for the direct dosage measurement on the skin of the patient throughout the treatment time will be given. Air measurements versus skin measurements will be outlined and tables given for back-scattering at commonly used wave lengths. Half of the period will be taken up with the above and round table discussion will follow. Throughout all, an earnest effort will be made to keep the matter within the scope of the clinical radiologist who has little knowledge of, or interest in, pure physical measurements. The instructor, having had experience in both clinical and physical work, will attempt to narrow the far-too-wide gap between the clinician and physicist.

COURSE: 210

Room: 738 **Period: T-2**

B. P. WIDMANN, M.D., Philadelphia, Pa.

Radiation Therapy in Cancer of the Skin

Technical procedures for the radium and roentgen treatment of cancer of the skin will be reviewed and analyzed in detail. A definite predetermined plan of dosage has been formulated according to the estimated surface area and thickness of the lesion. Special emphasis will be placed on the value of low voltage roentgen rays (110–135 kv.), and a clinical comparison with radium will be made according to a great variety of patterns for single and multiple radium tubes with different sizes of fields, filters and distances. Conclusions will be drawn from a large clinical experience with massive and fractional doses. Determinations of the "maximum safe dose," the "minimal effective dose," the daily intensity and the probable best rate of administration will be considered with specific recommendations after a routine experience demonstrating results and skin tolerance.

DIAGNOSTIC ROENTGENOLOGY

COURSE: 301

Room: 731 **Period: T-2**

PAUL A. BISHOP, M.D., Philadelphia, Pa.

Examination and Diagnosis of Lesions of the Temporomandibular Joint

The frequency with which injuries of the temporomandibular joint are overlooked, both clinically and roentgenographically, has led to an appalling number of permanent, serious disabilities of the mandible. A technique for the roentgenographic study of this joint is presented with lantern slide demonstration of acute and chronic injuries, as well as various non-traumatic conditions.

COURSE: 302

Room: 731 Period: W-2

PAUL A. BISHOP, M.D., Philadelphia, Pa.

A Classification of Fractures of the Ankle Based on the Mechanisms That Cause Them (Ashhurst and Bromer)

The use of "names" of fractures of the ankle is the cause of much confusion. "Pott's fracture" has been so popularized that, although it is a relatively infrequent fracture, it is the favorite clinical diagnosis in accident wards even in cases showing inward displacement, the opposite of a true Pott's fracture.

In 1922 Ashhurst and Bromer published a classification based on the mechanisms which cause the fractures, the characteristics of each being easily identified on roentgenograms. Thus, we are able to associate the various fractures produced by each acting force and separate those which, though similar anatomically, are caused by different forces.

It is a classification that justifies itself, and without classification "the relation of one lesion to another can be neither remembered nor understood in any department of knowledge; and comprehension is a prerequisite for intelligent memory and for rational diagnosis and treatment."

Lantern slide demonstration.

COURSE: 303

Room: 732 Period: T-2

C. W. BLACKETT, M.D., Boston, Mass.

The Shoulder

Chronic shoulder disability is frequently the result of injury to the short rotator tendons or their insertions or of pathological changes in these tendons. Such lesions can be frequently detected by roentgenograms made in the proper positions. The optimum positions for the study of the shoulder and the tendon insertions will be demonstrated and some of the pathological findings will be discussed and illustrated by lantern slides.

COURSE: 304

Room: 705 Period: T-1

FRANKLIN B. BOGART, M.D., Chattanooga, Tenn.

Pulmonary Changes in Some of the Rarer Infectious Diseases

The lung findings in undulant fever, tularemia, psittacosis, Rocky Mountain spotted fever, actinomycosis, blastomycosis, and other infectious diseases will be shown and discussed.

COURSE: 305

Room: 738 Periods: Th-1; F-1

RALPH S. BROMER, M.D., Philadelphia, Pa.

The Differential Diagnosis of Skeletal Changes Occurring in Diseases of Infants and Children

The time allotted will be spent in discussing the differential roentgen diagnosis of skeletal changes occurring in diseases of infancy and childhood. All such diseases cannot be included in the time available for the course. Case material will be chosen from the following list: congenital syphilis, rickets, infantile scurvy, tuberculosis, lead poisoning, the blood dyscrasias, xanthomatosis and allied conditions, osteogenesis imperfecta, achondroplasia, multiple enchondromata, multiple cartilaginous exostoses, metastases caused by neuroblastoma, osteochondritis and endocrine disturbances. Wherever possible the early roentgen changes will be emphasized. The question of differential diagnosis will be approached from the standpoint of the predisposition of the various diseases to affect certain bones or certain areas of individual bones. Thus in the case of the long bones, differential roentgen signs of the disease processes in the epiphysis, the diaphysis, the metaphysis, the periosteum, cortex, etc., will be given in detail.

COURSE: 306

Room: 731 Period: Th-2

JOHN R. CARTY, M.D., New York City

Soft Tissue Roentgenography

The pathological and anatomical basis of soft tissue roentgenography is briefly discussed, with particular reference to the newer concepts regarding fascial planes.

The essential points of the technical procedures are discussed and emphasis is placed on the necessity for an adequate understanding of the technical factors if success in this field is to be expected. Only practical aspects are to be considered, and a simple technical procedure is outlined which may be followed with the equipment found in the average roentgenographic office or department.

Following the discussion of technique the pathological conditions in the soft tissues which may be demonstrated roentgenographically are discussed and divided into appropriate groups, as follows:

Vascular Conditions: Soft tissue roentgenography is valuable in the study of arteriosclerosis and varicose veins. Information may be obtained as to whether or not the deep veins are involved. Occasional valuable information may be obtained regarding arteriovenous aneurysms.

Soft Tissue Tumors: Information regarding the extent and character and whether or not the tumor

is malignant may often be secured following roentgenographic examination. It is my opinion that no examination for bone tumor is complete without a soft tissue study also. Differential diagnosis between fibroid periosteal sarcoma and osteogenic sarcoma may sometimes be made. The presence of minute deposits of calcium caused by osteogenic elements in the soft tissues is the deciding factor. These calcium dots are usually entirely obliterated in roentgenograms made for bone detail. In hemangiomata distribution and location of the vessels supplying the tumor can often be ascertained. This may be of considerable value to the surgeon.

Muscle Conditions: Calcified hematomata are well shown in a soft tissue study. Occasionally a ruptured muscle may be demonstrated. Early atrophy at times may be demonstrated before there is actual reduction in size of the limb.

Infectious Conditions: Soft tissue roentgenography is invaluable in the diagnosis of gas gangrene, particularly for determining the extent of the disease. Soft tissue roentgenography is useful in the study of elephantiasis and may help in the differentiation of various types of edema. Soft tissue study of inflamed bursae is helpful, particularly where there is an absence of calcium-like material.

Soft tissue roentgenography of the larynx is briefly discussed, with special reference to carcinoma, edema and retropharyngeal abscesses.

In conclusion, the technique and scope of fasciagraphy is briefly discussed, and films shown which demonstrate its usefulness in certain selected conditions.

COURSE: 307

Room: 754 **Periods: Th-1; F-1**

JAMES T. CASE, M.D., Chicago, Ill.

The Roentgenologic Diagnosis of Carcinoma of the Colon

In the diagnosis of carcinoma of the colon the pathological and anatomical considerations vary according to the location of the tumor in the right or left half of the colon. In colonic polyposis the symptomatology, like the pathology, varies with the position of the tumor in the right or left colon. Special technique is a matter of utmost importance. Repetition of the examination is often necessary.

The technique of examination for and the roentgenologic manifestations of cancer of the colon will be discussed and illustrated.

COURSE: 308

Room: 752 **Period: T-2**

W. EDWARD CHAMBERLAIN, M.D., Philadelphia, Pa.

Technique and Interpretation of Oxygen Myelography

Oxygen has now been used successfully in hundreds of cases as the contrast medium for myelography. It has many advantages over other media but the roentgenographic requirements are very exacting.

Lumbar puncture vs. cisternal puncture for introduction of the oxygen; methods of increasing scope of lumbar puncture route; adaptation of ordinary conventional roentgenographic apparatus to this work; essential factors in technique; stereoscopy essential in lateral as well as dorsal projections; stereoscopic shift across long axis of spine; value of comparing lateral projections with spine in hyperflexion and hyperextension; value of "over-exposing" films; oblique projections of little value except in cervical and upper thoracic regions; suggestions for aftercare of patients.

COURSE: 309

Room: 736 **Period: Th-2**

C. G. DYKE, M.D., New York City

Roentgen Diagnosis of Brain Tumors

A review of the types of brain tumors and their individual characteristics will be discussed. Particular emphasis will be placed on the roentgenographic evidences produced by such tumors. The material will be illustrated with lantern slides.

COURSE: 310

Room: 736 **Periods: Th-1; F-1**

C. G. DYKE, M.D., New York City

Abnormal Pneumoencephalography With Particular Emphasis on Traumatic Conditions

Pneumoencephalography has been of great value in the diagnosis of many intracranial conditions. In this seminar it is planned to discuss a number of the lesions affecting the brain but special emphasis will be given to lesions of traumatic nature and their appearance in the pneumoencephalograms. Lantern slides will be used to illustrate the material.

COURSE: 311

Room: 732 **Period: W-2**

PEDRO L. FARIÑAS, M.D., Havana, Cuba

Bronchographic Examination in Primary Carcinoma of the Lungs

Bronchographic technique:

Simple bronchography (examination of the trachea and bronchi without contrast media).

Regular bronchography (examination of the trachea and bronchi with an opaque substance).

Mucosography (examination of the tracheobronchial mucosa coated with a very thin opaque layer).

Bronchographic aspects of the infiltrating and polypoid types of tumors.

Comparison between the bronchographic alterations and the anatomical specimen in the different types of bronchial tumors.

COURSE: 312

Room: 731 **Periods: T-1; W-1**

JOHN T. FARRELL, JR., M.D.
Philadelphia, Pa.

Roentgen Diagnosis of Lesions of the Esophagus

The technique of roentgen examination of the esophagus with liquids, semi-solids, and solids, together with the indications and limitations of each, will first be presented. This will be followed by consideration of the roentgen anatomy and physiology. Study of pathological states will embrace the diagnosis and differential diagnosis of congenital, inflammatory, traumatic, functional, and neoplastic conditions of the organ.

COURSE: 313

Room: 752 **Period: T-1**

GEORGE W. GRIER, M.D., Pittsburgh, Pa.

The Diagnosis of Congenital Heart Lesions in Children

Various malformations and congenital lesions of the heart will be discussed. Lesions which produce characteristic changes will be presented, as well as combinations of lesions. Other lesions in which the roentgen findings and clinical evidence combined will make a diagnosis will also be discussed. Films of a number of cases that have come to autopsy will be presented.

COURSE: 314

Room: 754 **Period: T-2**

A. O. HAMPTON, M.D., Boston, Mass.

The Roentgenologic Diagnosis of Pulmonary Infarction and Bronchial Occlusion; Technique and Interpretation of Venograms and their Importance in Prevention of Fatal Pulmonary Embolism

This Discussion will include:

1. The appearance of bronchial occlusion in the lateral view of the chest.
2. The roentgen diagnosis of pulmonary infarction with special reference to the indications for venograms.
3. A few remarks on the technique and interpretation of venograms.
4. The importance of the roentgen examination of the chest and deep veins of the legs in the prevention of fatal pulmonary embolism.

COURSE: 315

Room: 732 **Period: T-1**

HUGH F. HARE, M.D., Boston, Mass.

Myelography

Myelography, using either air or oil, may be diagnostic or may be used as an aid to diagnosis. For diagnostic procedures, lipiodol is preferable to oxygen, although the lipiodol procedure requires considerably more time and skill for its use. Oxygen myelography has its advantage in that it is quickly absorbed, but it is an aid to diagnosis rather than a diagnostic procedure. Its main disadvantage is that its use is limited to the diagnosis of lesions of the lumbar region.

COURSE: 316

Room: 731 **Periods: Th-1; F-1**

F. J. HODGES, M.D., Ann Arbor, Mich.

Non-tuberculous Lesions of the Chest

In studying roentgenograms of the chest the likelihood of encountering some form of tuberculosis must always be considered. Often it is difficult or impossible to rule out tuberculosis, but if other pulmonary diseases are kept in mind and if the various types of examination available to the roentgenologist are employed when indicated, the examiner can, in the majority of cases, report either helpful observations or a positive diagnosis to the referring physician. Accordingly, in this course non-tuberculous lesions presenting recognizable roentgenologic signs will be outlined, discussed and demonstrated with examples.

COURSE: 317

Room: 732 **Period: W-1**

PAUL C. HODGES, M.D., Chicago, Ill.

Further Developments in Roentgen Pelvimetry and Fetometry with Special Reference to Orthometric Reproduction

The indications for roentgen pelvimetry and fetometry, the technique of making the measurements, and the application of the measurements to clinical obstetrics will be considered. Models, specimens, charts and roentgenograms will be demonstrated. Opportunity will be given for questions and discussion.

COURSE: 318

Room: 738 **Periods: W-2; Th-2**

E. L. JENKINSON, M.D., Chicago, Ill.

Diaphragmatic Lesions Producing Gastrointestinal and Bizarre Cardiac Symptoms

Congenital short esophagus and its differentiation from diaphragmatic hernia will be covered. The frequency of hiatal hernia (para-esophageal) will be considered. The importance of the hernia as to the symptoms it may cause will also be discussed. The identification of a hernia is often of paramount importance in ruling out a suspected cardiac lesion. Pain referable to the precordium is often caused by a hernia and it is by no means essential that the hernia be very large. Lesions of the diaphragm will be classified as follows:

1. Congenital short esophagus
2. Para-esophageal hernia
3. Evisceration
4. Absence of the diaphragm
5. Thoracic stomach
6. Eventration

COURSE: 319

Room: 752 **Period: W-1**

A. S. MACMILLAN, M.D., Boston, Mass.

Roentgen Examination of the Accessory Nasal Sinuses

The technique of examination of the patient for suspected sinus disease will be considered. Particular stress will be placed upon four positions which the instructor considers the irreducible minimum in the examination of the sinuses.

Acute and chronic sinusitis, the sinus involvement in allergy and in malignant disease as well as the cause of exophthalmus in sinus involvement.

There is a great deal of discussion among otolaryngologists as to the value of the roentgen ray as an aid in the diagnosis. An attempt will be made to talk about the practical points in interpretation.

COURSE: 320

Room: 752 **Period: W-2**

A. S. MACMILLAN, M.D., Boston, Mass.

Roentgen Examination of the Mastoids

The technique of the examination of the patient for mastoid involvement in acute infections of the middle ear will be considered. Demonstrations of the various positions for the examination of the petrous pyramid in the search for involvement of this area as a complication of infection and invasions by new growths of the base of the skull and nasopharynx.

He will consider the rôle played by the roentgen ray in the determining of the optimum time for operation, the limitations of this type of examination and the need for the roentgenologist to acquaint himself with the problems of the surgeon.

COURSE: 321

Room: 705 **Period: W-1**

SHERWOOD MOORE, M.D., St. Louis, Mo.

Technique and Clinical Application of Body Section Roentgenography

The lecture will consist of a brief discussion of body section roentgenography and the methods employed for this purpose. There will be an appraisal, both anatomical and pathological, of the clinical use and value of this method of examination.

COURSE: 322

Room: 754 **Periods: T-1; W-1**

CARLETON B. PEIRCE, M.D., Montreal, Canada

Bronchographic Technique with Demonstration of the Anatomy and Pathologic Changes of the Bronchial Tree

The preparation of the patient for bronchography, the apparatus used and the various techniques for instillation of iodized oils will be demonstrated and discussed briefly.

Major emphasis will be placed on the demonstration of the topography of the normal bronchial tree, the localization and diagnosis of pathologic changes of the trachea and bronchi.

COURSE: 323

Room: 724 **Period: Th-2**

HOLLIS E. POTTER, M.D., Chicago, Ill.

Roentgen Diagnosis of Silicosis

Film and lantern slide demonstration of the essential changes in various stages of silicosis. Differentiation from linear, nodular, and massive lesions caused by other stimuli. Emphasis on the legal aspects of the disease.

COURSE: 324

Room: 705 **Period: Th-1**

SAMUEL A. ROBINS, M.D., Boston, Mass.

Uterosalpingography

This course concerns itself with the roentgen examination of the uterus and tubes by means of opaque media. The subject will be discussed under the following headings: (1) history; (2) apparatus and technique; (3) opaque media; (4) indications; (5) normal morphology; (6) physiologic variations;

Section on Instruction

ORDER SHEET

It is important to register for the Instruction Courses as early as possible since the number admitted to each course will be limited. *It is also very important that you list your first, second and third choice for each period.* All orders for tickets will be filled according to postmark on envelope.

Non-members, except full time graduate students in Radiology, will pay $1.00 for each course-period or a maximum of $5.00 for five or more such periods. *Non-members' fees must accompany this order sheet* and will not be returned unless cancellation is received before September 12, 1942.

Fill out the following (type or print):

..... Check ☐ Member ☐ Guest ☐ Graduate Student in Radiology at:

Last Name First Name or Initials

.....

Street Address

....

City State

For convenience in selecting your courses, consult the condensed schedule on the following pages.

CLAIMING INSTRUCTION COURSE TICKETS

Beginning Monday, September 14 those who have sent in advance orders may secure their tickets at the Registration Desk located on the Fourth Floor of the Palmer House. Tickets may also be secured for courses not filled.

Please remember that the Sequential Courses are continuous courses and run from two to four periods. *No part of them is repeated.* They are numbered A to E. All other courses are single-period courses and a few are repeated.

BE SURE TO FILL OUT SECOND AND THIRD CHOICES FOR EACH PERIOD

Period		First Choice		Second Choice		Third Choice	
		Course No.	Instructor	Course No.	Instructor	Course No.	Instructor
Tuesday	1						
	2						
Wednesday	1						
	2						
Thursday	1						
	2						
Friday	1						

Previous to September 5, 1942, send this order sheet to:
B. R. KIRKLIN, M.D., Mayo Clinic, Rochester, Minnesota.

After September 5, 1942, mail to:
B. R. KIRKLIN, M.D., American Roentgen Ray Society, Palmer House, Chicago, Illinois.

(7) pathologic variations; (8) pregnancy; (9) tumors (fibroids, polypi, malignancy); (10) inflammatory changes of the tubes; (11) tubal pregnancy; (12) sterility; (13) post-therapeutic changes in the uterus; (14) contraindications; (15) dangers.

Lantern slides of various physiologic and pathologic conditions of the uterus and tubes will be shown to evaluate this method of examination.

COURSE: 325

Room: 724 **Periods: T-2; W-2**

L. R. SANTE, M.D., St. Louis, Mo.

Atypical Pneumonias

Their place in the roentgenological group of pneumonias.

Their roentgenological differentiation from other types of pneumonic involvement.

Their pathological variation from other types of pneumonia.

COURSE: 326

Room: 705 **Period: F-1**

RICHARD SCHATZKI, M.D., Boston, Mass.

Technique of Examination of the Esophagus and Stomach; Varices; Gastritis

The general principles of the roentgen examination of the esophagus and stomach will be discussed with particular emphasis on the demonstration of the relief of these organs.

Stress will be laid upon the fact that the examination of the relief is a part of the routine examination and not a special type of examination. Exceptions to this rule will be shown.

The roentgen demonstration of esophageal varices and of gastritis will be discussed in more detail; technique; possibilities and limitations of the diagnosis; differential diagnosis; evaluation of the clinical importance of the roentgen examination in cases of varices and gastritis.

COURSE: 327

Room: 705 **Period: Th-2**

BARTON R. YOUNG, M.D., Philadelphia, Pa.

Roentgen Diagnosis of Diseases of the Air and Food Passages of the Neck; Planigraphy of the Larynx

The normal roentgen anatomy of the soft tissues of the air and food passages is reviewed in detail in the first part of the course. Roentgenoscopy is an indispensable preliminary procedure, so considerable time is devoted to a discussion of this part of the examination. The disturbances in deglutition due to tumor, infection or faulty innervation and the altered physiology and morphology of the larynx that result from any one of these conditions are readily detected by roentgenoscopic examination, and the roentgenoscopic appearances of some of the more common lesions are shown.

The changes in the air and food passages produced by foreign bodies and inflammatory and neoplastic diseases are demonstrated by exhibiting non-planigraphic and planigraphic roentgenograms. A technique for obtaining posteroanterior studies using non-planigraphic methods is outlined, and the value of this procedure for lateralizing laryngeal lesions is emphasized by showing illustrative cases.

The indications for body section roentgenography, and the results obtained from the application to the neck are presented. Planigraphy is of maximum value in the demonstration of tumors of the larynx but its superiority to conventional roentgen methods is not limited to the larynx. The planigraphic appearance of a number of interesting lesions in the larynx and cervical trachea is shown and discussed.

CONDENSED SCHEDULE OF COURSES ON TUESDAY

Code: T-1 **1st PERIOD—2:00 to 3:15** **Code: T-1**

Sequential Courses, Physics and Therapeutic Radiology		Diagnostic Roentgenology	
C—Kornblum	Roentgenology of the Urinary Tract	**304—Bogart**	Pulmonary Changes in Rarer Infectious Diseases: Undulant Fever, Tularemia, Actinomycosis, etc.
D—Murphy Ramsey	Radiologic-Pathologic Conference on Bone Tumors	**312—Farrell**	Roentgen Diagnosis of Lesions of the Esophagus
E—Wasson	Anatomy of the Lungs	**313—Grier**	Diagnosis of Congenital Heart Lesions in Children
101—Glasser Portmann	Dosage Measurements with Thimble Chamber: Practical Applications	**315—Hare**	Myelography: Technical Procedures and Difficulties Encountered
205—Merritt	Technique of Treatment of Cancer of Cervix and Results Therefrom	**322—Peirce**	Bronchographic Demonstration of Anatomy and Pathology of Bronchial Tree

Code: T-2 **2nd PERIOD—3:30 to 4:45** **Code: T-2**

Sequential Courses, Physics and Therapeutic Radiology		Diagnostic Roentgenology	
C—Kornblum	Roentgenology of the Urinary Tract	**301—Bishop**	Examination and Diagnosis of Lesions of the Temporomandibular Joint
D—Murphy Ramsey	Radiologic-Pathologic Conference on Bone Tumors	**303—Blackett**	The Shoulder
102—Henny	Roentgen Film Characteristics and Calibration of Apparatus and Developing Solution	**308—Chamberlain**	Technique and Interpretation of Oxygen Myelography
206—Newcomet	Radium Therapy of Hemangiomata	**314—Hampton**	Roentgenologic Diagnosis of Bronchial Occlusion and Pulmonary Infarction: Venography
210—Widmann	Radiation Therapy in Cancer of the Skin	**325—Sante**	Atypical Pneumonias

CONDENSED SCHEDULE OF COURSES ON WEDNESDAY

Code: W-1 **1st PERIOD—2:00 to 3:15** **Code: W-1**

Sequential Courses, Physics and Therapeutic Radiology		Diagnostic Roentgenology	
C—Kornblum	Roentgenology of the Urinary Tract	**312—Farrell**	Roentgen Diagnosis of Lesions of the Esophagus
D—Murphy Ramsey	Radiologic-Pathologic Conference on Bone Tumors	**317—P. C. Hodges**	Roentgen Pelvimetry and Fetometry; Orthometric Reproduction
E—Wasson	Physiology and Mechanics of the Chest and Particularly of the Lungs	**319—Macmillan**	Roentgen Examination of the Accessory Nasal Sinuses
105—Weatherwax	Radium Dosage	**321—Moore**	Technique and Clinical Application of Body Section Roentgenography
205—Merritt	Technique of Treatment of Cancer of Cervix and Results Therefrom	**322—Peirce**	Bronchographic Demonstration of Anatomy and Pathology of Bronchial Tree

Code: W-2 **2nd PERIOD—3:30 to 4:45** **Code W-2**

Sequential Courses, Physics and Therapeutic Radiology		Diagnostic Roentgenology	
C—Kornblum	Roentgenology of the Urinary Tract	**302—Bishop**	Fractures of the Ankle: Classification
D—Murphy Ramsey	Radiologic-Pathologic Conference on Bone Tumors	**311—Fariñas**	Bronchographic Diagnosis in Primary Carcinoma of Lungs
104—Taylor	Measurement of Quantity and Quality of Roentgen Rays	**318—Jenkinson**	Diaphragmatic Lesions Producing Gastrointestinal and Bizarre Cardiac Symptoms
202—Lenz	Roentgen Therapy of Lymphoblastoma	**320—Macmillan**	Roentgen Examination of the Mastoids
204—Martin	Radiation Treatment of Cancer of Lip and Mouth, Including Cervical Metastasis	**325—Sante**	Atypical Pneumonias

CONDENSED SCHEDULE OF COURSES ON THURSDAY

Code: Th-1 **1st PERIOD—2:00 to 3:15** **Code: Th-1**

Sequential Courses, Physics and Therapeutic Radiology		Diagnostic Roentgenology	
B—Golden Swenson	Roentgenology of the Small Intestine	**305—Bromer**	Differential Diagnosis of Skeletal Changes in Diseases of Children
E—Wasson	Classification of Diseases of the Lungs	**307—Case**	Roentgenologic Diagnosis of Cancer of the Colon
105—Weatherwax	Radium Dosage	**310—Dyke**	Abnormal Pneumoencephalography
201—Ernst	Radiation Treatment of Cancer of the Cervix	**316—F. J. Hodges**	Non-tuberculous Lesions of the Chest
207—Pfahler	Radiation Treatment of Cancer of the Breast	**324—Robins**	Uterosalpingography

Code: Th-2 **2nd PERIOD—3:30 to 4:45** **Code: Th-2**

Sequential Courses, Physics and Therapeutic Radiology		Diagnostic Roentgenology	
A—Donaldson	Radiologic Jurisprudence	**306—Carty**	Soft Tissue Roentgenography
B—Golden Swenson	Roentgenology of the Small Intestine	**309—Dyke**	Roentgen Diagnosis of Brain Tumors
106—Williams	Absorption of Roentgen Radiation	**318—Jenkinson**	Diaphragmatic Lesions Producing Gastrointestinal and Bizarre Cardiac Symptoms
203—Leucutia	Radiation Therapy in Tumors of Bone	**323—Potter**	Roentgen Diagnosis of Silicosis
208—Richards	Treatment of Carcinoma of the Mouth	**327—Young**	Diagnosis of Diseases of the Air and Food Passages of the Neck: Planigraphy of the Larynx

CONDENSED SCHEDULE OF COURSES ON FRIDAY

Code: F-1 **1st PERIOD—2:00 to 3:15** **Code: F-1**

Sequential Courses and Therapeutic Radiology		Diagnostic Roentgenology	
A—Donaldson	Radiologic Jurisprudence	**305—Bromer**	Differential Diagnosis of Skeletal Changes in Diseases of Children
B—Golden Swenson	Roentgenology of the Small Intestine	**307—Case**	Roentgenologic Diagnosis of Cancer of the Colon
E—Wasson	Roentgenologic Diagnosis of Diseases of the Lungs	**310—Dyke**	Abnormal Pneumoencephalography
207—Pfahler	Radiation Treatment of Cancer of the Breast	**316—F. J. Hodges**	Non-tuberculous Lesions of the Chest
209—Taft	Dosage Measurement from a Clinical Standpoint	**326—Schatzki**	Technique of Examination of the Esophagus and Stomach for Varices and Gastritis

BULLETIN OF THE AMERICAN COLLEGE OF RADIOLOGY

AMERICAN MEDICAL ASSOCIATION CLARIFIES MEDICAL PRACTICE IN HOSPITALS

Patients receiving the services of a radiologist during hospitalization should receive a bill for professional services rendered in the name of the radiologist. This is the purport of a resolution introduced by Dr. E. H. Skinner for the Section on Radiology, and unqualifiedly endorsed by the House of Delegates of the American Medical Association at its June meeting in Atlantic City. While the resolution pertains to all types of medical services and the general problem of practice in the hospital, its provisions will be of special interest to radiologists.

Referring to the continued encroachment of hospitals on the practice of medicine, the resolution called upon the House of Delegates to reaffirm previously enunciated principles opposing the practice of medicine by hospital corporations through the medium of employed physicians, and provided that "all fees for medical services rendered in hospitals should be collected by or on the account of the physician rendering such service." The complete text of the resolution follows:

WHEREAS, the House of Delegates approved a resolution, introduced by Dr. Harry H. Wilson, at the 1941 session, instructing "The Board of Trustees of the American Medical Association to confer with similar committees representing the American Hospital Association and the Protestant and Catholic hospital associations of the United States, the conjoint committees to study and submit reports to their respective national bodies, in which would be outlined platforms or principles designed to clarify the relation of medical services that may be offered in prepayment hospitalization and similar plans, the same to be in line with the basic principles laid down in the past by the House of Delegates and other authorities of the American Medical Association . . . "; and

WHEREAS, the Board of Trustees was requested in the same resolution to "proceed to these matters as expeditiously as may be possible"; and

WHEREAS, evidence of continued encroachment of hospitals into the practice of medicine are manifest in numerous group hospitalization plans which offer certain medical services on a service basis as a part of hospital care, and in plans adopted by numerous hospitals which include certain medical services in an "all inclusive" per diem rate for hospital care: now therefore be it

RESOLVED, that the House of Delegates reaffirms the principles enunciated in official resolutions over a period of many years opposing the practice of medicine by corporations or the interjection of a third party into the personal relationship and financial transaction between doctors and patients; and be it further

RESOLVED, that hospital corporations should not be permitted to engage in the practice of medicine through the medium of employed physicians or to enter into contracts with any individual, group, or agency, whereby the hospital agrees to furnish any medical services; and be it further

RESOLVED, that, to the end that hospitals be discouraged from offering the services of licensed physicians to patients on a contract or service basis, all fees for medical services rendered in hospitals should be collected by or on the account of the physician rendering such service, and all physicians concerned in the care of a patient should give or send directly to the patient or other responsible party a statement showing charges for professional services rendered; provided, however, that an exception to the foregoing principle may be made in the case of a formally organized partnership of physicians which acts in the capacity of an individual; and be it further

RESOLVED, that the definitions of medical service and hospital service as applied to the principles stated herein shall be consistent with those applied in previous declarations of the House of Delegates in which medical services are construed as the services rendered by licensed practitioners of medicine, and hospital service as limited to hospital accommodations such as bed, operation room, medicines, surgical dressings, and general nursing care; and be it further

RESOLVED, that the Board of Trustees be

urged to proceed to the clarification of these problems as requested by the House of Delegates at its last annual session.

The Reference Committee on Legislation and Public Relations, to which it was referred, reported to the House of Delegates that the resolution was consistent with principles previously stated by the House and recommended its adoption. The House adopted the report without dissent or debate.

Numerous physicians, including several Delegates, appeared before the Reference Committee in behalf of the resolution. During the hearing it was pointed out that the recommendations contained in the resolution would not prohibit hospitals from collecting for radiological charges at the cashier's office, but would require that such charges be rendered on the billhead and in the name of the physician-radiologist. By separating the identity of the physician from the hospital, the reference committee was told, there would be less tendency for hospitals to attempt to include radiological services as a part of hospital care in group hospitalization or inclusive-rate plans.

Also considered by this committee was a resolution introduced by Dr. Lyell C. Kinney, Delegate from California, pertaining to payments by insurance companies for medical services rendered in the hospital. The text of the resolution as introduced, follows:

WHEREAS, It is desirable that physicians and insurance companies cooperate to the fullest extent, especially in the interest of persons covered by health and accident insurance; and

WHEREAS, A serious situation has arisen in the administration of certain health and hospitalization schemes whereby medical services are being billed under the term "hospital services" and are being paid for by insurance companies as they are labeled hospital services; and

WHEREAS, The continuation or extension of such practices will inevitably lead to the inclusion of any type of medical service under the label "hospital service," at the convenience of the corporations involved and to the detriment of medical care; now therefore be it

RESOLVED, That the House of Delegates of the American Medical Association hereby requests insurance companies to cooperate with the organized medical profession to the end that hospitalization policies shall include only hospital benefits. If the inclusion of indemnification for medical services, such as surgery or radiology, is desired, then payment of such shall be made only on receipt of certified statement from a physician that he has rendered such. Fees for medical services should be paid to physicians via indemnity to the assured, or by check payable jointly to assured and physician. This practice should be maintained irrespective of whether a hospital chooses to bill for medical services as a part of its hospital bill; and be it further

RESOLVED, That the House of Delegates of the American Medical Association requests hospitals and physicians to cooperate with it in this important step, by seeing that bills for hospital and medical services are clearly distinguished; the latter should bear the name of the physician rendering the service to indicate clearly that the charge is for medical service.

The reference committee did not mention in its report to the House that universal conformance with the provisions of the Skinner resolution would likely achieve the desirable objectives of the Kinney resolution, but asked that the latter be referred to the Board of Trustees for study as to the "feasibility of action requested and as to ways and means of accomplishing the desired results." The House of Delegates accepted the recommendation and failed to adopt the resolution as introduced.

In its report to the House of Delegates, the Board of Trustees explained its failure to attempt a clarification of the issues referred to in the first section of the Skinner resolution by asking for time for further study by the Bureau of Medical Economics. The following statement appeared in a supplemental report presented by the Board:

The Board of Trustees has had meetings previously with hospital associations, and at least one of these hospital associations has announced plans at variance with principles set forth by the House of Delegates.

The Board has already considered this matter as a committee of the whole, and, in view of the divergent views concerning hospital plans, felt that nothing would be gained by further conferences with hospital associations until more information is available through the Bureau of Medical Economics. Such studies and compilations are in active progress, but, owing to inevitable dislocation due to the war and to constant changes in plans for hospitalization, and the heavy responsibilities laid on the Bureau of Medical Economics by the war effort, these studies have not been completed in spite of the employment of additional help. The Board would suggest that opportunity be given for further study based on the studies by the Bureau of Medical Economics.

Another resolution of particular interest to radiologists was introduced by Dr. Dwight L. Wilbur, Delegate from California. It called attention to the existence of commercial laboratories which advertise to the public and which frequently give rebates to referring physicians and declared it unethical for physicians to refer patients to such concerns. The reference committee to which it was referred expressed its serious concern over the situation described and presented the following substitute resolution, which was adopted by the House:

WHEREAS, It has been brought to the attention of the House of Delegates that the unscrupulous practice of rebates to physicians is being engaged in by various commercial organizations, laboratories, supply houses and in some professional relationships between certain physicians; and

WHEREAS, All such practices are clearly in violation of the Principles of Medical Ethics; therefore be it

RESOLVED, That the House of Delegates of the American Medical Association express stern disapproval of the practice by any of the members of its component societies of referring patients to commercial organizations, laboratories or other physicians who advertise to the public and others than the medical profession, who employ so-called steerers or cappers or who pay, or offer to pay, rebates or commissions in any guise whatsoever, or who in any other manner violate the Principles of Medical Ethics of the American Medical Association; and be it further

RESOLVED, That any member violating these resolutions be subject to such disciplinary action as is deemed advisable by the county society in which such physician holds membership; and be it further

RESOLVED, That the Secretary of the American Medical Association be instructed to send a copy of these resolutions to each state and county society accompanied by a letter to the secretary of each setting forth that all such unethical practices are disreputable and unscrupulous and, if not controlled, may soon besmirch the reputation of the entire medical profession.

The California delegation had been instructed to introduce the resolution by the California Medical Association following an investigation by one of its committee which revealed, among other things, that several large commercial x-ray laboratories were offering rebates to physicians who patronized them. The American Medical Association, by its adoption of the resolution, encourages county medical societies to discipline members who are guilty of participating in such practices.

The House of Delegates disapproved of a resolution introduced by New York requesting that legislation be sought to amend the Social Security Act so that persons rendering medical care to recipients-of-aid from any governmental agency may be paid directly by that agency instead of the benefits being paid in cash to the recipient. Modifying previous declarations of principle which demand that medical insurance benefits be paid in cash to the patient, the House adopted a resolution approving medical service plans which provided benefits in kind, i.e. service instead of cash, "when sponsored by a constituent state medical association or a component county medical society." This leaves unchanged those principles previously adopted by the American Medical Association prohibiting the inclusion of any

medical service among the benefits offered in hospital service plans.

A proposal by the Judicial Council of the American Medical Association that section delegates be deprived of their vote in the House was approved by the Reference Committee on Sections and Section Work which will submit an amendment to the Constitution at the next annual session. The reason for the proposal is not clear. Certainly the Section on Radiology and all radiologists would be materially affected if the present excellent work of their elected delegate was interfered with in any manner. It is likely that other sections representing the specialties will feel likewise. That the proponents of the amendment are themselves somewhat obfuscated in their aims is indicated by their use of the term "ex officio delegates without the right to vote" in describing the status of section delegates in the proposed amendment. By parliamentary law and legal usage "ex officio" delegates are delegates by right of some office they hold and are entitled to full voting privileges the same as any other delegate. A delegate elected by a section would not be an "ex officio" delegate, but a delegate. Whether these delegates are to be deprived of their vote will apparently be decided by the House at the time of its next annual session.

PROTECTION OF RADIUM DURING AIR RAIDS*

Immediately following this country's entry into the present war, the National Bureau of Standards began to receive numerous requests from users of radium for advice regarding its storage during air raids. From the number of requests and the technical questions that were submitted to the Bureau of Standards it became evident that there is a widespread need of and desire for information concerning such protection of radium. Consequently the National Bureau of Standards, under its Director, Dr. Lyman J. Briggs, appointed a special committee to draw up some suggestions which might be followed in the storage of radium during air raids. They have just issued a very comprehensive pamphlet which is made available to all users of radium who desire information concerning its care. The committee, in arriving at the recommendations which are set forth in some detail in the pamphlet, have kept in mind the desirability of simple expedients that can be put into operation quickly. Those who are interested in the subject can obtain the pamphlet from the Superintendent of Documents, Washington, D. C. at the small cost of ten cents.

* Protection of Radium During Air Raids. National Bureau of Standards Handbook H38. Issued by the U. S. Department of Commerce, National Bureau of Standards. Paper. Price, 10 cents. For sale by the Superintendent of Documents, Washington, D. C. Pp. 17, with 3 illustrations. Washington, D. C.: United States Government Printing Office, 1942.

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 105 Rutledge Ave.
Charleston, S. C.

A RADIATION THERAPY FORM
WITH SUGGESTIONS FOR ITS USE

By HILLYER RUDISILL, JR., M.D., F.A.C.P., F.A.C.R.
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THE radiation therapy form here illustrated is the result of a gradual evolution over a period of about ten years. It does not emphasize any local trend and I hope it may be as satisfactorily used in any department. A detailed study was made of twenty forms before this one was completed.

On the face of the form (Fig. 1) the uppermost section of general information is fairly standardized and no innovation has been introduced. The blank section beneath this is for drawings, photographs or anatomical stamps. The next heading of PHYSICAL FACTORS follows the present tendency of listing several complete formulae, which may subsequently be referred to by number. This simplifies the daily recording. The addition of column 11 for the constancy meter reading (an iometer in our installation) and column 12 for the percentage depth dose at 10 cm., compared to the roentgens per minute in air, seemed to be logical for completeness. If one fills in column 12, D:D10, it is probable that the entire chart may be completed. For the percentage depth dose determinations we are now using the graphs of Roth.[1]

If the AREAS to be used are planned in advance the treatments can be more methodically administered and when the areas are listed serially, under the respective digits, one does not have to write them again but uses the numbered columns on both the front and back of the sheet. A feature of this section is a space at the bottom of each area column for the ESTIMATED TUMOR DEPTH from the surface of this area. There are many ways to determine tumor depth. Some are extremely accurate and most methods require considerable attention, time and frequently special apparatus. Our section is purposely headed "estimated" tumor depth as we are using a method that is simple but gives only an estimated or approximate determination. A check with cases of tumors of the mouth and of the cervix shows that it is sufficiently accurate for clinical dosimetry.

As an illustration the measurements are described in a case of carcinoma of the cervix uteri. A standard cross section anatomy book[2] was used and the level through the middle of the cervix was found. This was traced off and a copy of it is used for all patients regardless of the size. The cross section measures exactly 13 cm. from front to back, which is 80 per cent of the actual size of the cadaver average from which the cross section was drawn. I am giving this as incidental information for the section is utilized because the various organs and parts are in correct relation to one another and to the surface of an average patient. The size of the cross section is disregarded as soon as the suprapubic anteroposterior diameter is found and the centimeter equivalent factor is determined. For example, the patient to be treated measures 21 cm. suprapubically (Fig. 2). On the cross section this diameter is 13 cm. In using the cross section to chart this patient's tumor

JOHN GASTON HOSPITAL

X-RAY THERAPY

NAME DATE NO. AGE COL.

ADDRESS REF. BY:

DIAGNOSIS: Carcinoma of Cervix Uteri.

COURSE OF TREATMENT PLANNED: Pre-Radium X-Ray Series:
200 r to 2 areas daily with a total of 10 applications to each of the 4 standard areas. Twenty treatment days.

PHYSICAL FACTORS

FORMULA	DESCRIPTION OF APPARATUS	KV	FILTRATION mms. plus L.O Al INHERENT	ADDED	TOTAL	HVL MM	MA	DIST CM	S/M AIR	IONOTER	D:DIO
1	Half Wave	200	.2 Cu	.5 Cu	.7 Cu	1.0	25	50	30	1:86	46
2											
3											

AREAS

	I	II	III	IV	V	VI
	P R.A.O.	E L.A.O.	L R.P.O.	V L.P.O.	I	S
ESTIMATED TUMOR DEPTH	11 cms.	11 cms.	9 cms.	9 cms.		

SUMMARY

NO. TREATMENTS	TOTAL PER AREA IN AIR						GRAND TOTAL
20	2000	2000	2000	2000			ON SURFACE 8000
ELAPSED DAYS	**TOTAL PER AREA TO TUMOR**						**ACTUAL TUMOR DOSE**
25	820	820	1040	1040			3720

ESTIMATED RECOVERY FACTOR
60%, plus 10% for 5 days without treatment

MAXIMUM EFFECTIVE TUMOR DOSE: 30%
R 1160
T.E.D. 3.

Fig. 1

depth the diameter of the cross section divided by the actual diameter of the patient will give us our centimeter equivalent (13 cm.÷21 cm.=0.6 cm.). Special scales can be ruled off with centimeters represented by 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9 cm. This will take care of all pelvic sizes from 13 to 32.5 cm. We have had our pelvic cross section mimeographed with the central beams from our usual four area technique, right and left anterior and posterior

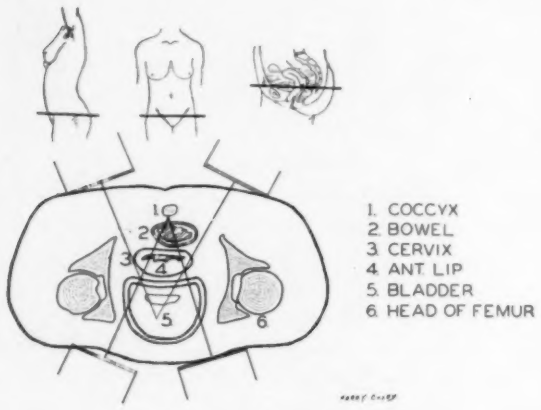

Fig. 2

obliques. The tumor depth is then measured along each central ray and charted under the respective area column.

The bottom section of the front of the sheet, SUMMARY, is filled in at the completion of the series from the DAILY RECORD OF TREATMENT, on the back of the sheet (Fig. 3). This daily record needs only the date, formula number and field size with the number of roentgens given in the correct area column. The last column for total daily dose can be kept as separate daily totals or as a "running" grand subtotal. With this type of daily recording we can see at a glance how many treatments have been given to each area. When the series is completed the totals per area and the grand total of all areas are filled in and we turn back to the summary at the bottom of the front of the sheet. The totals just found are entered and also the elapsed days between the beginning and the ending of the series. The number of treatments and the elapsed days are of course the same provided a treatment has been given every day. However, many prefer to skip some days for various reasons and we do not treat routinely on week-ends. It takes twenty-five elapsed days to give our twenty treatment series. This summary contains places for information that should always be included but often is not. Everyone instinctively hesitates to record ACTUAL TUMOR DOSE, knowing that it will be somewhere between a fairly approximate to a grossly inaccurate figure. I feel that a definite figure is better than no figure at all and while it may be only approximate it is at least finite and of comparative relative-value. Therefore, there is not only a place for the depth dose to the tumor but also spaces for ESTIMATED RECOVERY FACTOR so that the MAXIMUM EFFECTIVE TUMOR DOSE (accumulated dose) may be described in roentgens and threshold erythema doses, T.E.D.

The tumor depth dose from each area may be quickly and accurately found if the 10 cm. depth dose, D:D10, and the tumor depths from the surface of the areas treated have been recorded. This is an extremely simple one step determination with Roth's nomogram.[1] The ESTIMATED RECOVERY FACTOR used on the illustrating chart, of 60 per cent, is based on the arithmetical determination from our twenty treatment series. The recovery allowed is 50 per cent the first day, 25 per cent daily through the sixth day, 20 per cent recovery from the seventh through the twelfth and 10 per cent daily thereafter.[3] The five elapsed days warrant an additional 10 per cent recovery so the actual MAXIMUM EFFECTIVE DOSE (accumulated dose) is only 30 per cent. The grand total maximum effective dose then is 30 per cent of 8,000 or 2,400 roentgens. Each skin area has a 600 r accumulation and the maximum effective dose to the tumor is 1,160 r. Biologically this is correct as the skin reaction is between a first and

DAILY RECORD OF TREATMENT

DATE	TREATMENTS	FORMULA	AREA I SIZE IN CMS.	AREA I R AIR	AREA II SIZE IN CMS.	AREA II R AIR	AREA III SIZE IN CMS.	AREA III R AIR	AREA IV SIZE IN CMS.	AREA IV R AIR	AREA V SIZE IN CMS.	AREA V R AIR	AREA VI SIZE IN CMS.	AREA VI R AIR	TOTAL DAILY
8-11	1	1	10^2	200	10^2	200									400
8-12	2	1					10^2	200	10^2	200					800
8-13	3	1	10^2	200	10^2	200									1200
8-14	4	1					10^2	200	10^2	200					1600
8-15	5	1	10^2	200	10^2	200									2000
8-18	6	1					10^2	200	10^2	200					2400
8-19	7	1	10^2	200	10^2	200									2800
8-20	8	1					10^2	200	10^2	200					3200
8-21	9	1	10^2	200	10^2	200									3600
8-22	10	1					10^2	200	10^2	200					4000
8-25	11	1	10^2	200	10^2	200									4400
8-26	12	1					10^2	200	10^2	200					4800
8-27	13	1	10^2	200	10^2	200									5200
8-28	14	1					10^2	200	10^2	200					5600
8-29	15	1	10^2	200	10^2	200									6000
9-1	16	1					10^2	200	10^2	200					6400
9-2	17	1	10^2	200	10^2	200									6800
9-3	18	1					10^2	200	10^2	200					7200
9-4	19	1	10^2	200	10^2	200									7600
9-6	20	1					10^2	200	10^2	200					8000
	21														
	22														
	23														
	24														
	25														
	26														
	27														
	28														
	29														
	30														
	31														
	32														
	33														
	34														
ELAPSED DAYS	TOTAL PER AREA		2000		2000		2000		2000						GRAND TOTAL 8000

Fig. 3

second degree Holzknecht erythema and the tumor effect approximates the one expected from about 3 T.E.D. Needless to say, this amount of radiation is not expected to be curative; it is a preliminary to radium application. Finally, work is well under way on an algebraic recovery formula that will provide for elapsed days.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

Erikson, Stig. Naevus epithelioma cylindromatosus. *Acta radiol.*, 1941, *22*, 217–236.

Various names are given to this form of tumor. In America it is often known as benign epithelioma of the scalp. It was first described by Spiegler in 1899. It is a rare disease.

The author describes 8 cases of the multiple type and 6 of the solitary type seen at the Radiumhemmet. The histopathological findings are shown by photomicrographs. In 3 cases transition stages between naevus epithelioma cylindromatosus and epithelioma adenoides cysticum were seen. In one case the findings suggested that degeneration into a basal cell cancer had occurred but there was no absolute proof of this.

Among the 8 multiple cases there was a family history in 7, but there was no family history in any of the solitary cases. This suggests that the two forms may differ biologically even though the histopathological picture is the same. The family tree of a family is presented in which the disease was followed through three generations. Among the 32 persons in the family 9 had these tumors. The heredity is of the simple dominant type; that is, if one of the parents is afflicted half of the children have the disease, while none of the children of healthy parents are affected.

These tumors grow very slowly and except for the disfigurement cause little discomfort. If large enough to cause any disturbance they may be treated with radium or roentgen rays. At Radiumhemmet 2 cases were treated with radium and 3 with roentgen rays. The tumors disappeared or decreased in size and hyalinization took place.—*Audrey G. Morgan.*

Spiers, F. W. A model head and dose finder. *Brit. J. Radiol.*, April, 1940, *13*, 147–148.

A dose finder is described and illustrated by means of which it is possible to make a simple and rapid determination of the dose at any point inside a model head from any combination of circular beams. The apparatus is similar in some respects to that designed by Mayneord but two light beams are used to locate points within a laminated model head. The dosage is then calculated by means of an isodose chart which can be rotated about its chief axis.

This apparatus is particularly valuable in cases in which roentgen or radium rays are used to treat lesions in the mouth. As the dosage estimations are made on a model head they do not apply exactly to all cases but they do cover a large number of actual cases and are of great practical use.—*Audrey G. Morgan.*

Ahlbom, Hugo E. The results of radiotherapy of hypopharyngeal cancer at the Radiumhemmet, Stockholm, 1930 to 1939. *Acta radiol.*, 1941, *22*, 155–171.

The author considers as hypopharyngeal cancer all carcinomas from the valleculae to the upper end of the esophagus with the exception of intrinsic carcinoma of the larynx. During the ten year period under discussion 291 cases have been seen at Radiumhemmet. Of these 56 (19 per cent) were not treated by irradiation because the patients were in too bad physical condition. Of the 235 patients treated, 129 were women and 106 men. Teleradium was preferred for the smaller, well demarcated tumors while roentgen treatment was given in the larger ones with metastases. This meant that most of the men were given teleradium and most of the women roentgen treatment.

The technique is discussed and tables given showing the results of treatment. The number of five year cures is only 9, or 7 per cent. No fixed rule can be set for dosage and it must be adapted to the individual case. But in general a total roentgen dosage of 5,000 to 6,000 r should be given over a period of twenty to thirty days. The treatment is given with 170 to 180 kv. and the Thoraeus filter at 60 cm. distance. With this treatment prolonged to forty to fifty days an effective tumor dose is not given, while if the time is shortened to less than twenty days there is danger of necrosis.

It is often difficult to tell whether death is caused by further growth of the tumor or by the effects of irradiation. Four of the patients died of a radiation injury of the cervical spinal cord. For this reason they no longer give teleradium treatment from a posterior field but from one or two fields in the anterior midline.

In the future if the intended dosage cannot be given in a first series of treatments they plan to give another smaller series of roentgen or teleradium treatments after the skin reaction has healed but before the tumor has had time to recover and start to grow again, that is to say one and one-half to two months after the end of the first series. With this change they hope to get better results.—*Audrey G. Morgan.*

STRANDQVIST, MAGNUS. Transthoracic roentgen treatment of cancer of the oesophagus. *Acta radiol.*, 1941, *22*, 172–193.

The author reports 36 patients with cancer of the esophagus treated at the Radiumhemmet from 1936 to 1939. They were given transthoracic roentgen treatment through six narrow fields, three anterior and three posterior. The method of calculating the direction of the beam so that the cross-fire should be directly over the tumor is described. At Radiumhemmet they do not describe dosage in roentgens measured in air but give the surface or depth dose in roentgens with backscatter, that is the tissue roentgen. The total tumor doses in these cases varied from 3,300 to to 5,500 r given over a period of eighteen to fifty-three days and the total skin doses between 2,000 and 3,500 r on each of the six fields. Although the daily doses were large there was no roentgen sickness.

Only 4 patients were alive and free of symptoms after two years, but the palliative results were excellent. The results apparently depend on tumor dosage. The total tumor dose must be very large and the number of treatment days carefully considered in each case. A given tumor dose has much less effect when fractionated over a long period than over a short one. In the cases of two year cures the total dose was 4,350 to 5,000 r over thirty-five to forty days. In order to work out the ideal dosage all workers are asked to keep careful records of tissue dosage and the number of treatment days. A chart is given illustrating how this may be done. The total tumor dose in tissue roentgens is indicated on the abscissa and the number of treatment days on the ordinate. The cases dead of cancer are marked with circles, cases dead of perforation with plus and those dead of other complications with x. Symptom-free two-year cures are marked with black dots and a curve worked out showing the optimum dosage. If such reports were collected from a large number of cases the information obtained would be of great value.—*Audrey G. Morgan.*

ENGEL, MILTON B., BRONSTEIN, I. P., BRODIE, A. G., and WESOKE, PHILLIP. IX. A roentgenographic cephalometric appraisal of untreated and treated hypothyroidism. *Am. J. Dis. Child.*, June, 1941, *61*, 1193–1214.

This article is a report on craniofacial growth in children with thyroid deficiency. The purpose of the study was to indicate the deviations from normal growth which occur and to point out the efficacy of thyroid therapy in inducing developmental progress in the craniofacial areas. The authors' conclusions are as follows:

Craniofacial, dental and carpal ossification patterns of development of untreated children with hypothyroidism lag behind those of children who are given thyroid therapy. The deficiency in the cranium lies in the occipital, parietal and, to much lesser extent, in the frontal area. The cranial base is shortened, and the spheno-occipital synchondrosis and the sutures of the vault are abnormally wide. The face shows a generalized retardation of growth as a result of the slowed velocity of growth of its components, that is, the mandible, the maxilla and the nasal bone. The teeth are delayed in their eruption, but they are not malformed. Differentiation and ossification of carpal centers are disturbed and retarded, and the roentgenograms show persistence of infantile characters.

Craniofacial, dental and carpal patterns of development in untreated children with hypothyroidism are retarded when compared with those of normal subjects of the same age. The differences are merely an accentuation of those noted between treated and untreated cretins.

Children with hypothyroidism who have been treated regularly since early childhood closely approach normal levels of craniofacial development. Their patterns of dental development and progress in ossification are normal.

Thyroid deficiency affects craniofacial growth by retarding its velocity rather than by modifying its pattern.—*R. S. Bromer.*

HEYMAN, J., REUTERWALL, O., and BENNER, S. The Radiumhemmet experience with radiotherapy in cancer of the corpus of the uterus. *Acta radiol.*, 1941, *22*, 11–98.

The treatment of cancer of the body of the uterus at Radiumhemmet is discussed. Reuterwall gives a histological classification into twelve groups. The different types of cancer are illustrated with photomicrographs. The

prognosis, however, seems to depend on the extent of the disease and the method of treatment rather than on the histological type of the tumor. A statistical study shows that the degree of radiosensitiveness does not depend on the stage of maturity of the cells.

In attempting to classify the cases clinically, they found that in addition to tumors of the body of the uterus alone there were three other groups, one in which there was involvement of both the body and the cervix, one in which there was involvement of uterus and ovaries and one in which there was involvement of several pelvic organs. These groups are not included in the consideration of the results because it cannot be proved definitely that the cancer originated in the body of the uterus.

Up to 1930 they used only one irradiator, which contained 35–45 mg. radium element, inserted into the uterus. From then on they began developing their technique of multiple containers each containing 8 mg. radium element. They finally developed their present method of putting each lead irradiator into a porcelain capsule and packing the uterus with them. The method of packing is described and illustrated. On the basis of empirical experience they have adopted a dose of 1,500 mg-el-hr., given twice with an interval of three weeks between treatments. At each treatment the patient remains in the hospital four or five days. Roentgen irradiation is given if the uterus is fixed or if the tumor has extended beyond the uterus. As a rule one field is irradiated per day, generally two to three weeks after the second packing of the uterus with radium. Usually a skin dose of 400 to 500 r is given, including backscatter; each field is given a total dose of 1,000 to 1,200 r. Conditions: Thoraeus filter (0.4 mm. tin, 0.25 Cu and 1 Al), 50 cm. skin-focus distance, about 170 kv. constant voltage. Benner describes the physical methods of determining the required dosage of radium.

The results based on a series of 402 cases observed for five years or longer are presented. The details are given in tabulated form. The first year in which the packing method was used in all suitable cases was 1934. The results of radiotherapy, with hysterectomy in cases of failure, show that 75 per cent of the clinically operable cases treated in 1934 were alive and free of disease after five years. This result is 20 to 30 per cent higher than that obtained with previous methods. The authors conclude that the packing method of radium treatment, with hysterectomy in case of failure, is the method of choice in inoperable and borderline cases. They await the results of further experience to determine whether it should be used in definitely operable cases.—*Audrey G. Morgan.*

Walker, James Z. A new technique of treatment of carcinoma of the cervix uteri by combining x ray and radium. *Brit. J. Radiol.*, Jan., 1940, *13*, 1–24.

In the treatment of carcinoma of the cervix of the uterus uniformity of dosage is extremely important for if less than the lethal tumor dose is given to any part of the tumor it will recur. On the other hand, the dose must not be beyond what the normal tissues can tolerate. Because of the variations in location and spread of the tumor and in the diameter of the pelvis in different patients it is not possible to devise any single method of radium application that will meet all requirements.

The author has therefore devised a method of combined radium and roentgen treatment by means of which uniform dosage can be applied to all parts of the tumor in all cases. He uses the r as the unit of radium dosage in all calculations. Five types of intrauterine radium applicators are described and illustrated. They contain from one to five radium tubes. Isodose charts are given for the different applicators and tables showing the details of the supplementary roentgen treatment to be given with each for different sizes of pelvis. No roentgen treatment is given at the center of the tumor where the radium is completely effective and the treatment is so arranged that as the radium effect decreases the roentgen action increases so that the dosage of irradiation is uniform throughout the tumor. By a study of the isodose charts and the tables of roentgen treatment it should be possible to apply this method in any case.—*Audrey G. Morgan.*

Berven, Elis G. E. 177 Fälle mit primärem Vulvakarzinom. (One hundred and seventy-seven cases of primary carcinoma of the vulva.) *Acta radiol.*, 1941, *22*, 99–154.

The author reviews the literature of primary cancer of the vulva and discusses its treatment at Radiumhemmet in Stockholm. Statistics report various percentages of five year cures, generally 4 to 10 per cent with surgical treatment; some hospitals report five year cures in 17 to 35 per cent of cases, and Taussig even reports 65 per cent. The surgical mortality

varies from 10 to 15 per cent. Stoeckel collected 126 cases treated by irradiation alone, with a recovery rate of 11.9 per cent.

The development of radiation treatment of this form of cancer at Radiumhemmet from 1910 is sketched. At first the radium was applied to the surface of the tumor, then a plastic mass was used, and in 1921 the present method of treatment was adopted. All cases since 1922 have been treated in this way. It consists of electrocoagulation of the tumor combined with teleradium treatment of the regional glands and in operable cases surgical removal of the glands. These patients were almost all old and in poor condition and therefore surgical removal of the glands was performed in only 38 cases. The technique of the electrocoagulation and teleradium treatment is described.

Among these 177 cases 65, or 36.7 per cent, were alive and well after five years. There was local recurrence in not more than 20 of the cases—a local cure therefore of 90 per cent. There may, however, be local recurrence or metatasis after more than five years. But this is unusual. Two of these patients died of metastasis in the sixth year after treatment. Large size of the tumor is not a contraindication to electrocoagulation. In fact, life is often rendered bearable for a considerable time in cases of very large tumors with almost unendurable pain. In Stage I—cases limited to part of the vulva and not ulcerated—there were 59.3 per cent five year cures; in Stage II—tumors localized to part of the vulva but ulcerated—22.9 per cent, and in Stage III—tumors extending beyond the vulva with metastases—five year cure was attained in 3.8 per cent. Surgical removal of glands should not be attempted in the latter group. There was 8.5 per cent surgical mortality with electrocoagulation and removal of glands. Tables showing details of the results are given and the article is profusely illustrated with photographs of cases.

It may be that part of the good results were due to the unusual strength of these old Swedish women. Seven of them were between eighty and ninety years of age.—*Audrey G. Morgan.*

Tod, Margaret C. The treatment of metastases. *Brit. J. Radiol.*, May, 1940, *13*, 163–171.

A brief review is given of the methods of treatment of metastases in use at the Manchester Radium Institute. The curability of metastases depends partly on the mode of transmission of the cancer, but to a greater degree on its radiosensitiveness. When the cancer spreads through the lymphatics it is possible to foretell to a certain extent where metastases will occur and give prophylactic treatment, which, however, is not truly prophylactic in the sense of preventing involvement, but rather curative of small metastases that have not become clinically evident. When the cancer is carried through the circulation it is impossible to tell where metastases may occur and metastases can only be treated as they develop.

Illustrative treatment charts are given for radiosensitive and radioresistant types of tumor. Radiosensitive tumors must be given a small dosage over a large region and radioresistant ones a much larger dosage over a small localized area.

Four techniques for palliative therapy are discussed: (1) Localized treatment for single metastases from sensitive tumors, such as enlarged lymph nodes in the mediastinum secondary to a cervical lymphosarcoma. Treatment of the mediastinum may be necessary to relieve dyspnea; 1,600 r may be given in four days to the mediastinum. (2) A growth restraint technique for metastases from resistant tumors such as osteogenic sarcoma or malignant melanoma. Considerable periods of remission may be obtained by localized treatment of metastases in lymph nodes; 3,000 r in three weeks over the actual tumor without any attempt to go beyond it is a good growth restraint dose. A single field is usually used. (3) The chasing technique which treats bloodborne metastases as they occur. Roentgen rays or radium implants may be used. (4) Symptomatic palliative therapy. In late stages there may be severe pain due to involvement of bone, pressure on nerves or ulceration; or dyspnea from enlarged mediastinal nodes may call for treatment. This is purely a palliative treatment and should not be given unless there is a reasonable hope of relieving symptoms.

This brief account of the methods in use at the Manchester Radium Institute is merely an attempt to tabulate the common varieties of treatment with the hope that it may help to adapt methods of treatment of type of tumor. No large survival figures can be given. Among the sensitive tumors with metastases with patients alive five years after treatment are one Ewing's tumor out of 2; one seminoma out of 4; 7 out of 30 cases of carcinoma of the breast treated in 1933.—*Audrey G. Morgan.*

Forssberg, Arne. Über die Reaktionen von Phycomyces Blakesleeanus nach Röntgen- und γ-Bestrahlung. (The reactions of *Phycomyces blakesleeanus* after roentgen and radium irradiation.) *Acta radiol.*, 1941, *22*, 252–259.

There are still many unsolved problems relating to the mechanism of reactions to irradiation and it is therefore important to find sensitive objects for experimentation. The reactions of the unicellular fungus *Phycomyces blakesleeanus* are briefly described and its radiosensitiveness illustrated by curves which show that reactions can be obtained with doses as small as 0.001 r. This is much smaller than any dose with which biological effects have been produced heretofore.—*Audrey G. Morgan.*

MISCELLANEOUS

Seemann, Herman E., and Vaeth, William C. A rotary shutter for x rays. *Brit. J. Radiol.*, May, 1940, *13*, 183–184.

A rotary roentgen-ray shutter is described and illustrated. It may be made any required size. It was designed for heavily filtered 200 kv. rays. It consists chiefly of a rotary disc with alternate open and opaque sectors and has a control mechanism operated by an electromagnet. The radiopaque sections are 94 per cent lead and 6 per cent antimony alloy about 1 cm. thick. This material has better mechanical properties than lead. Several exposures may be made for one winding, which is convenient when remote control is desired. The motion of the shutter wheel for opening and closing is just the same so that each part of the roentgen-ray beam is turned on for exactly the same length of time. The shutter will accommodate a roentgen-ray beam directed anywhere between the vertical and the horizontal. —*Audrey G. Morgan.*

Hederman, J. P. Radiographic mensuration and localisation: a new method. *Brit. J. Radiol.*, April, 1940, *13*, 123–126.

A special caliper is described and illustrated which is used for pelvimetry and the localization of foreign bodies. It has two long arms and a short arm which can be fixed to either of the long ones. Formulae for calculating the pelvic measurements and the depth of a foreign body in the tissues are given. The method is simple and should supersede the complicated Hirtz compass and the various methods which use strings and plumb bobs.—*Audrey G. Morgan.*

Busanovich, G. M. The copying of roentgenograms. *Radiology*, Feb., 1941, *36*, 212–216.

The most satisfactory method of reproducing roentgenograms for most purposes, particularly for publication, is by photographic reduction. A reduced positive is made from the negative roentgenogram and the negative final copy is produced by contact printing or projection of the intermediate positive. Details are given in regard to the choice of film and developer for the making of the intermediate positive, the exposure and the making of the final copy. A plate is reproduced which gives serial views of a case of tuberculosis showing closing of a cavity and associated non-tuberculous lesions in the lower part of the lung.—*Audrey G. Morgan.*

Burke, Hugh E. Tuberculosis in rabbits; a further comparison of the roentgenological and pathological findings in primary and reinfection experimental pulmonary tuberculosis in rabbits. Part I. Primary tuberculosis. *Am. Rev. Tuberc.*, Sept., 1940, *42*, 343–375.

Lewis and Montgomery injected large amounts of bovine tubercle bacilli intratracheally into dogs. The dogs developed no fever but lost weight and coughed. Patches of red to gray consolidation were found in the lungs of those killed before the fourteenth day. In those killed between the fourteenth and the twentieth day, areas of necrosis and caseation were found. Dogs which were not killed died of generalized miliary tuberculosis. Other investigators have reproduced results such as these. Primitive tubercles have been demonstrated as early as five minutes following intratracheal injection and caseation has been found as early as the fourth or fifth day thereafter. Soper, Sampson and Haskins and later Willis obtained roentgenographic as well as clinical and pathological studies of this sort. All of their subjects progressed to fatal termination.

The author has studied this problem in the combined manner, including clinical, roentgenographic and postmortem examinations in 55 healthy rabbits injected intratracheally with measured quantities of bovine tubercle bacilli: 26 were injected with 0.1 mg. of bacilli; 18 with 0.5 mg. and 11 with 10. mg.

The results varied with different dosages but they were very similar for all-receiving the same dosage.

With 0.1 mg. of bacilli the rabbits did not manifest illness during early or intermediate stages. Abnormal shadows were visualized in

chest roentgenograms between the tenth and twenty-eighth days. These shadows increased until the end of the first month or the early part of the second month. Necropsies then showed only a few tubercles and one or two fibrocaseous foci—usually in the apical portion of the left lower lobe or in the wall of the main bronchus. Then, after one to six months, abnormal shadows reappeared and the rabbits became definitely ill, dying three to four months later.

With a dosage of 0.5 mg. of the bacilli, the preliminary effects were similar to those just described. Abnormal shadows appeared between the twelfth and twenty-second days. They reached maximum dimensions during the latter part of the first month or early part of the second. Their size was comparable to that of the group receiving only 0.1 mg. of the organisms and in this group, too, the lesions disappeared between the third and eighth months. They recurred several months thereafter and progressed to fatal terminations in three to six months following their reappearance. Terminal lesions included: pleural adhesions, pneumothorax, parenchymal caseation, cavitation, lymph node enlargements and fibroses. Tubercles were found in the kidneys and intestines of every animal autopsied (6). One of the animals did not show any lesions until after the twenty-nith month when minute lesions appeared in all parts of both lung fields. Necropsy revealed disseminated miliary lesions.

With the injection of 1.0 mg. of the bacilli, abnormal shadows were detected earlier than with the smaller dosages. Cavitation developed in some instances. Where densities developed, they seldom disappeared and when they did, new abnormal shadows reappeared soon—with fatal terminations in one to three months after reappearance.

Thus, it appears that the number of invading microorganisms is of great importance in the prognosis of primary pulmonary tuberculosis. The author is unable to explain the reactivation process following apparent involution of the lesions—the "diphasic phenomenon."—*A. A. de Lorimier.*

BURKE, HUGH E. Tuberculosis in rabbits; a further comparison of the roentgenological and pathological findings in primary and reinfection experimental pulmonary tuberculosis in rabbits. Part II. Reinfection tuberculosis. *Am. Rev. Tuberc.*, Oct., 1940, *42*, 499–535.

In 1903, Trudeau contrasted the survival rate of rabbits subjected to intrapulmonary inoculation of virulent tubercle bacilli after having received a preliminary intravenous injection of attenuated organisms as compared with such inoculations directly into control animals. He found that those which had been injected intravenously with attenuated bacilli prior to the intrapulmonary injection of the virulent bacilli lived longer than did the control animals. Pathological studies accomplished by Nichols indicated that the immunized rabbits killed twenty-two days following the virulent inoculation showed a greater reaction than did the controls. Some of the former contained areas of tuberculous pneumonia in contrast to the lungs of the controls which contained tubercles joined by cellular infiltration. Immunized rabbits killed 110 days after the virulent inoculation (all controls had died by this time) contained only scattered minute tubercles consisting of epithelioid cells and a few a larger tubercles with caseating centers.

In 1927, Soper, Sampson and Haskins and later Oppenheimer performed similar studies including roentgenological examinations. Consolidations were found in the lungs about the fifth day; later, there were recessions of these lesions.

The author has previously reported on findings concerned with the primary phase. In the present series, inoculations of a heavy suspension of avirulent tubercle bacilli were first accomplished. These were injected into the groin, three weeks prior to intratracheal injections. Localized lesions developed which did not completely resolve. Intratracheal injections of virulent bovine tubercle bacilli were later performed. Two of the animals were injected intratracheally with 0.1 mg. of bovine tubercle bacilli; 18 with 0.5 mg. and 11 with 1.0 mg.

Abnormal shadows were regularly detected in chest roentgenograms of the animals with reinfection disease on the first day following intratracheal injection—whereas in the case of the primary phase, they did not appear until the tenth to the twenty-eighth days. Cavities were found in a number of the cases of the intratracheal inoculations which had previously been vaccinated whereas only 2 such were found among the group which had not been vaccinated. All rabbits which manifested re-

activation of the disease died of widespread tuberculosis. However, those receiving only a small dose of bacilli intratracheally and which failed to present roentgenological evidence of extension of the disease, remained well for periods of one and one-half to two and a quarter years.

Pathologically the reinfection cases differed from the non-vaccinated in the following manner: Early lesions developed more rapidly (red hepatization occurred within a day following intratracheal injection; gray hepatization, on the second or third day—versus ten to twenty-eight days in the case of the primary consolidations); caseous foci in the lungs of healthy rabbits injected with 1.0 mg. bacilli and vaccinated rabbits injected with 0.5 and 1.0 mg. of the microorganisms were larger than those in the lungs of other rabbits; cavities were found—a few in the first group; many in the second. New lesions failed to develop in the lungs of a few of the vaccinated rabbits injected with 0.1 mg. of the bacilli—but in most of those injected with this dosage and in all, with greater dosage, new lesions did develop and all died of widespread tuberculosis.

These studies appear to indicate that a cold abscess produced by a single subcutaneous injection of avirulent bacilli confers upon rabbits a degree of immunity sufficient, in certain cases, to prevent the animals from dying of tuberculosis, following the intratracheal injection of a relatively small dose (0.1 mg.) of bovine tubercle bacilli.—*A. A. de Lorimier.*

Wilson, C. W. Protection in radium teletherapy at Westminster Hospital: A summary of measurements of gamma-ray doses made over a number of years with condenser ionisation chambers carried by the staff. *Brit. J. radiol.*, March, 1940, *13*, 105–107.

The ionization chamber used in these experiments is illustrated. It is of electron metal and has a sensitivity of about 500 volts/roentgen. It is worn in the front coat pocket of the staff member while he is exposed to the radiation.

The measurements of the radiation received by each individual during his work were made over three different periods, the first in which the treatment unit was a 2 gram unit with a lead container averaging 5 cm. in thickness, the second when a 4 gm. unit was used with a container of tungsten alloy with an average thickness of 5 cm. During the third period the 2 gm. unit and the 4 gm. unit were used together in the same room.

The tables of dosage received by the operators during these periods show that at no time did they seriously exceed the tolerance dose of 0.25 roentgen per day. The amounts were greatest during the use of the 2 gm. unit. The decrease with the 4 gm. unit was probably due to the fact that the operators exercised greater care because they knew that the amount of radium was doubled. When both units were used in the same room special precautionary measures were adopted, such as directing the beams at the end walls into regions which could not be occupied by anyone and arranging the radiation so that when it was directed toward a region occupied by any operator it passed through a maximum thickness of absorbing material in the container. When not in use the containers were lowered into lead wells with walls more than 5 cm. thick. The time the operator remained in the room was reduced to a minimum by notices posted in the room asking the patients to cooperate in this matter. This reduced the dosage received by the personnel even further which seems to show that care in handling radium units is as good a safety measure as any. None of the personnel in these experiments had any illness that could be attributed directly to the radiation.—*Audrey G. Morgan.*

Lasnitzki, Ilse, and Lea, D. E. The variation with wavelength of the biological effect of radiation. *Brit. J. Radiol.*, May, 1940, *13*, 149–162.

The authors' method of testing the differences in biological effect of radiation of different wave lengths was to compare the effect of the different wave lengths on mitotic division in tissue cultures grown in vitro. The tissue cultures were exposed to the various radiations, incubated for a suitable time, then fixed and stained and the mitotic figures counted. The doses measured in roentgens (ionization in air) were converted into ionization in tissue to be sure the results were valid. The method of making this conversion is described and the results are given in the form of a table.

Roentgen rays of effective wave lengths of 0.107, 0.150 and 0.363 Ångström units were found to have about the same biological effect

but their effect was about twice that of the same number of roentgens of gamma rays. The table of conversion from ionization in air to ionization in tissue shows that this was a real difference and not merely an apparent one due to lack of proportion in the air and tissue ionizations.

By making use of the results of other workers, a curve was drawn showing the relative effectiveness of different radiations extending from hard roentgen rays to neutrons. This table shows that roentgen rays and neutrons have about the same effect but that gamma rays are less effective and that as wave length decreases they become progressively less effective.—*Audrey G. Morgan.*

Sievert, Rolf M. Zur theoretisch-mathematischen Behandlung des Problems der biologischen Strahlenwirkung. (A theoretical-mathematical treatment of the biological action of rays.) *Acta radiol.*, 1941, *22*, 237–251.

The author discusses the cell as a complicated system of a large number of substances or processes. Whenever for any reason one of these substances increases unduly, processes are set in motion to restore the normal balance. From this, with certain simplifications, he works out mathematically the quantitative changes which a substance in the cell undergoes after a roentgen or radium irradiation. He arrives at differential equations which can be solved graphically and gives curves representing the changes in such a substance with different times of irradiation and with two different intensities of irradiation. This theory explains periodic fluctuations of a type often seen in irradiation experiments. The time factor calculated theoretically for a single uninterrupted irradiation agrees very well with the results found by Sievert and Forssberg in irradiating *Drosophila* eggs.—*Audrey G. Morgan.*

Pickhan, A. Practical results of researches on irradiation effect of genes as applied to roentgen therapy and roentgen diagnosis. *Radiology*, Feb. 1941, *36*, 145–146.

It has been shown consistently by a large number of investigators that short wave radiation possesses a mutation producing effect. This has been demonstrated with ultraviolet light, grenz rays, roentgen rays of different hardness, radium rays and alpha rays, beta and cathode rays, and gamma rays.

The author's experimental work on the CIB stock of *Drosophila melanogaster* demonstrates the following facts: (1) The rate of mutation is in direct and linear proportion to the height of the dosage of radiation used. (2) The time factor is without effect on the rate of mutation; the smaller radiation doses and the weakest intensity by repetition produce cumulation. (3) The process of mutation is not reversible.

In the living world there is a minimal mutation rate. With 1,000 r this minimal spontaneous mutation rate of about 0.3 to 0.6 per cent in *Drosophila melanogaster* can be increased to about 42 per cent.

From the practical point of view, this experimental work leads to the conclusion that great attention should be paid to the number of roentgens delivered in roentgen examinations of the female pelvis since mutations may be produced. It must also be remembered that the time factor is without effect so that repeated small doses, independent of the time in which they are given, lead to cumulation.—*Wendell C. Hall.*

JOHN H. LAWRENCE
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